

Part II  
Protecting Air Quality

Chapter 5  
Protecting Air Quality

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## Protecting Air Quality

*This chapter will help you address:*

- *Airborne particulates and air emissions that can cause human health risks and damage the environment by adopting controls to minimize particulate emissions.*
- *Assessing risks associated with air emissions and implementing pollution prevention, treatment, or controls as needed to reduce risks for a facility's waste management units not addressed by requirements under the Clean Air Act.*
- *Using a Clean Air Act Title V permit, at facilities that must obtain one, as a vehicle for addressing air emissions from certain waste management units.*

**H**ealth effects from airborne pollutants can be minor and reversible (such as eye irritation), debilitating (such as asthma), or chronic and potentially fatal (such as cancer). Potential health impacts depend on many factors, including the quantity of air pollution to which people are exposed, the duration of exposures, and the toxicity associated with specific pollutants. An air risk assessment takes these factors into account to predict the risk or hazards posed at a particular site or facility.

This chapter will help you address the following questions.

- Is a particular facility subject to CAA requirements?
- What is an air risk assessment?
- Do waste management units pose risks from volatile air emissions?
- What controls will reduce particulate and volatile emissions from a facility?

Air releases from waste management units include particulates or wind-blown dust and gaseous emissions from volatile compounds

It is recommended that every facility implement controls to address emissions of airborne particulates. Particulates have immediate and highly visible impacts on surrounding neighborhoods. They can affect human health and can carry constituents off site as well. Generally, controls are achieved through good operating practices.

For air releases from industrial waste management units, you need to know what regulatory requirements under the Clean Air Act (CAA) apply to your facility, and whether those requirements address waste management units. The followup question for facilities whose waste management units are not addressed by CAA requirements, is “are there risks from air releases that should be controlled?”

This Guide provides two tools to help you answer these questions. First, this chapter includes an overview of the major emission control requirements under the CAA and a decision guide to evaluate which of these

might apply to a facility. The steps of the decision guide are summarized in Figure 1. Each facility subject to any of these requirements will most likely be required to obtain a CAA Title V operating permit. The decision guide will help you clarify some of the key facility information you need to identify applicable CAA requirements.

If your answers in the decision guide indicate that the facility is or might be subject to specific regulatory obligations, the next step is to consult with EPA, state, or local air quality program staff. Some CAA regulations are industry-specific and operation-specific within an industry, while others are pollutant specific or specific to a geographic area. EPA, state, or local air quality managers can help you precisely determine applicable requirements and whether waste management units are addressed by those requirements.

You might find that waste management units are not addressed or that a specific facility clearly does not fit into any regulatory category under the CAA. It is then prudent to look beyond immediate permit requirements to assess risks associated with volatile organic compounds (VOCs) released from the unit. A

two-tiered approach to this assessment is recommended, depending on the complexity and amount of site specific data you have.

**Limited Site-Specific Air Assessment:**

The CD-ROM version of the Guide contains the Industrial Waste Air Model (IWAIR). If a waste contains any of the 95 constituents included in the model, you can use this risk model to assess whether VOC emissions pose a risk that warrants additional emission controls or that could be addressed more effectively with pollution prevention or waste treatment before placement in the waste management unit. The IWAIR model allows users to supply inputs for an emission estimate and for a dispersion factor for the unit.

**Comprehensive Risk Assessment:** This assessment relies on a comprehensive analysis of waste and site-specific data and use of models designed to assess multi-pathway exposures to airborne contaminants. There are a number of modeling tools available for this analysis. You should consult closely with your air quality management agency as you proceed.



Airborne emissions are responsible for the loss of visibility between the left and right photographs of the Grand Canyon. Source: National Park Service, Air Resources Division.

# I. Federal Airborne Emission Control Programs

Four major federal programs address airborne emissions that can degrade air quality. For more information about the CAA and EPA's implementation of it, visit the Technology Transfer Network, EPA's premier technical Web site for information transfer and sharing related to air pollution topics, at [www.epa.gov/ttn](http://www.epa.gov/ttn).

If the facility is a major source or otherwise subject to Title V of the CAA, the owner must obtain a Title V operating permit. These permits are typically issued by the state air permitting authority. As part of the permitting process, you will be required to develop an emissions inventory for the facility. Some states have additional permitting requirements. Whether or not emissions from a waste management unit will be specifically addressed through the permit process depends on a number of factors, including the type of facility and state permitting resources and priorities. It is prudent, however, where there are no applicable air permit requirements to assess whether there might be risks associated with waste management units and to address these risks.

## A. National Ambient Air Quality Standards

The CAA authorizes EPA to establish emission limits to achieve National Ambient Air Quality Standards (NAAQS).<sup>1</sup> EPA has designated NAAQS for the following criteria pollutants: ozone, sulfur dioxide, nitrogen dioxide, lead, particulate matter (PM), and carbon monoxide. The NAAQS establish individual pollutant concentration ceilings that should

be rarely exceeded in a predetermined geographical area (National Ambient Air Quality District). NAAQS are not enforced directly by EPA. Instead, each state must submit a State Implementation Plan (SIP) describing how it will achieve or maintain NAAQS. Many SIPs call for airborne emission limits on industrial facilities.

If a waste emits VOCs, some of which are precursors to ozone, the waste management unit could be affected by EPA's NAAQS for ground-level ozone. Currently, states are implementing an ozone standard of 0.12 parts per million (ppm) as measured over a 1-hour period. In 1997, EPA promulgated a revised standard of 0.08 ppm with an 8-hour averaging time to protect public health and the environment over longer exposure periods<sup>2</sup> (see 62 FR 38856, July 18, 1997). EPA is currently developing regulations and guidance for implementing the 8-hour ozone standard. EPA expects to designate areas as attaining or not attaining the standard in 2004. At that time, areas not attaining the standard will need to develop plans to control emissions and to demonstrate how they will reach attainment. Consult with your state to determine whether efforts to comply with the ozone NAAQS involve VOC emission limits that apply to a specific facility. General questions about the 8-hour standard should be directed to EPA's Office of Air Quality Planning and Standards, Air Quality Strategies and Standards Division, Ozone Policy and Strategies Group, MD-15, Research Triangle Park, NC 27711, telephone 919 541-5244.

## B. New Source Performance Standards

New Source Performance Standards (NSPSs) are issued for categories of sources that cause or contribute significant air pollu-

<sup>1</sup> 42 U.S.C. § 7409

<sup>2</sup> For a discussion of the history of the litigation over the revised ozone standard and EPA's plan for implementing it, including possible revisions to 40 CFR 50.9(b), see 67 FR 48896 (July 26, 2002).

tion that can reasonably be anticipated to endanger public health or welfare. For industry categories, NSPSs establish national technology-based emission limits for air pollutants, such as particulate matter (PM) or VOCs. States have primary responsibility for assuring that the NSPSs are followed. These standards are distinct from NAAQS because they establish direct national emission limits for specified sources, while NAAQS establish air quality targets that states meet using a variety of measures that include emission limits. Table 1 lists industries for which NSPSs have been established and locations of the NSPSs in the Code of Federal Regulations. You should check to see if any of the 74 New Source Performance Standards (NSPSs)<sup>3</sup> apply to the facility.<sup>4</sup> Any facility subject to a NSPS must obtain a Title V permit (see Section D below).

### C. National Emission Standards for Hazardous Air Pollutants

Section 112 of the CAA Amendments of 1990<sup>5</sup> requires EPA to establish national standards to reduce emissions from a set of certain pollutants called hazardous air pollutants (HAPs). Section 112(b) contains a list of 188 HAPs (see Table 2) to be regulated by National Emission Standards for Hazardous Air Pollutants (NESHAPs) referred to as Maximum Achievable Control Technology (MACT) standards, that are generally set on an industry-by-industry basis.

MACT standards typically apply to major sources in specified industries; however, in some instances, non-major sources also can be subject to MACT standards. A major source is defined as any stationary source or group of stationary sources that (1) is located within a contiguous area and under common control, and (2) emits or has the potential to emit at

least 10 tons per year (tpy) of any single HAP or at least 25 tpy of any combination of HAPs. All fugitive emissions of HAPs, including emissions from waste management units, are to be taken into account in determining whether a stationary source is a major source. Each MACT standard might limit specific operations, processes, or wastes that are covered. Some MACT standards specifically cover waste management units, while others do not. If a facility is covered by a MACT standard, it must be permitted under Title V (see below).

EPA has identified approximately 170 industrial categories and subcategories that are or will be subject to MACT standards. Table 3 lists the categories for which standards have been finalized, proposed, or are expected. The CAA calls for EPA to promulgate the standards in four phases. EPA is currently in the fourth and final phase of developing proposed regulations.

CAA also requires EPA to assess the risk to public health remaining after the implementation of NESHAPs and MACT standards. EPA must determine if more stringent standards are necessary to protect public health with an ample margin of safety or to prevent an adverse environmental effect. As a first step in this process the CAA requires EPA to submit a Report to Congress on its methods for making the health risks from residual emissions determination. The final report, Residual Risk Report to Congress (U.S. EPA, 1997b), was signed on March 3, 1999 and is available from EPA's Web site at <[www.epa.gov/ttn/oarpg/t3/reports/risk\\_rep.pdf](http://www.epa.gov/ttn/oarpg/t3/reports/risk_rep.pdf)>. If significant residual risk exists after application of a MACT, EPA must promulgate health-based standards for that source category to further reduce HAP emissions. EPA must set residual risk standards within 8 years after promulgation of each NESHAP.

<sup>3</sup> 40 CFR Part 60.

<sup>4</sup> While NSPSs apply to new facilities, EPA also established emission guidelines for existing facilities.

<sup>5</sup> 42 U.S.C. § 7412.

Table 1. Industries for Which NSPSs Have Been Established

For electronic versions of the 40 CFR Part 60 subparts referenced below, visit [www.access.gpo.gov/nara/cfr](http://www.access.gpo.gov/nara/cfr). Be sure to check the Federal Register for updates that have been published since publication of this Guide.

Facility	40 CFR Part 60 subpart	Facility	40 CFR Part 60 subpart
Ammonium Sulfate Manufacture	PP	Petroleum Dry Cleaners, Rated Capacity 84 Lb	JJJ
Asphalt Processing & Asphalt Roofing Manufacture	UU	Petroleum Refineries	J
Auto/Id Truck Surface Coating Operations	MM	Petroleum Refinery Wastewater Systems	QQQ
Basic Oxygen Process Furnaces after 6/11/73	N	Phosphate Fertilizer-Wet Process Phosphoric Acid	T
Beverage Can Surface Coating Industry	WW	Phosphate Fertilizer-Superphosphoric Acid	U
Bulk Gasoline Terminals	XX	Phosphate Fertilizer-Diammonium Phosphate	V
Calciners and Dryers in Mineral Industry	UUU	Phosphate Fertilizer-Triple Superphosphate	W
Coal Preparation Plants	Y	Phosphate Fertilizers: GTSP Storage Facilities	X
Commercial & Industrial SW Incinerator Units	CCCC	Phosphate Rock Plants	NN
Electric Utility Steam Generating Units after 9/18/78	DA	Polymer Manufacturing Industry	DDD
Equipment Leaks of VOC in Petroleum Refineries	GGG	Polymeric Coating of Supporting Substrates Fac.	VVV
Equipment Leaks of VOC in SOCMIs	VV	Portland Cement Plants	F
Ferroalloy Production Facilities	Z	Pressure Sensitive Tape & Label Surface Coating	RR
Flexible Vinyl & Urethane Coating & Printing	FFF	Primary Aluminum Reduction Plants	S
Fossil-fuel Fired Steam Generators after 8/17/71	D	Primary Copper Smelters	P
Glass Manufacturing Plants	CC	Primary Lead Smelters	R
Grain Elevators	DD	Primary Zinc Smelters	Q
Graphic Arts: Publication Rotogravure Printing	QQ	Rubber Tire Manufacturing Industry	BBB
Hot Mix Asphalt Facilities	I	Secondary Brass and Bronze Production Plants	M
Incinerators	E	Secondary Lead Smelters	L
Industrial Surface Coating, Plastic Parts	TTT	Sewage Treatment Plants	O
Industrial Surface Coating-Large Appliances	SS	Small Indust./Comm./Institut. Steam Generating Units	DC
Industrial-Commercial-Institutional Steam Generation Unit DB		Small Municipal Waste Combustion Units	AAAA
Kraft Pulp Mills	BB	SOCMI - Air Oxidation Processes	III
Large Municipal Waste Combustors after 9/20/94	EB	SOCMI - Distillation Operations	NNN
Lead-Acid Battery Manufacturing Plants	KK	SOCMI Reactors	RRR
Lime Manufacturing	HH	SOCMI Wastewater	YYY
Magnetic Tape Coating Facilities	SSS	Stationary Gas Turbines	GG
Medical Waste Incinerators (MWI) after 6/20/96	EC	Steel Plants: Elec. Arc Furnaces after 08/17/83	AAA
Metal Coil Surface Coating	TT	Steel Plants: Electric Arc Furnaces	AA
Metallic Mineral Processing Plants	LL	Storage Vessels for Petroleum Liquids (6/73–5/78)	K
Municipal Solid Waste Landfills after 5/30/91	WWW	Storage Vessels for Petroleum Liquids (5/78–6/84)	KA
Municipal Waste Combustors (MWC)	EA	Sulfuric Acid Plants	H
New Residential Wood Heaters	AAA	Surface Coating of Metal Furniture	EE
Nitric Acid Plants	G	Synthetic Fiber Production Facilities	HHH
Nonmetallic Mineral Processing Plants	OOO	Volatile Storage Vessel (Incl. Petroleum) after 7/23/84	KB
Onshore Natural Gas Processing Plants, VOC Leaks	KKK	Wool Fiberglass Insulation Manufacturing Plants	PPP
Onshore Natural Gas Processing: SO <sub>2</sub> Emissions	LLL		

Table 2  
HAPs Defined in Section 112 of the CAA Amendments of 1990

CAS#	CHEMICAL NAME	CAS#	CHEMICAL NAME	CAS#	CHEMICAL NAME
75-07-0	Acetaldehyde	72-55-9	DDE	67-72-1	Hexachloroethane
60-35-5	Acetamide	334-88-3	Diazomethane	822-06-0	Hexamethylene-1,6-diisocyanate
75-05-8	Acetonitrile	132-64-9	Dibenzofurans	680-31-9	Hexamethylphosphor-amide
98-86-2	Acetophenone	96-12-8	1,2-Dibromo-3-chloropropane	110-54-3	Hexane
53-96-3	2-Acetylaminofluorene	84-74-2	Dibutylphthalate	302-01-2	Hydrazine
107-02-8	Acrolein	106-46-7	1,4-Dichlorobenzene(p)	7647-01-0	Hydrochloric acid
79-06-1	Acrylamide	91-94-1	3,3-Dichlorobenzidine	7664-39-3	Hydrogen fluoride (Hydrofluoric acid)
79-10-7	Acrylic acid	111-44-4	Dichloroethyl ether (Bis(2-chloroethyl)ether)	123-31-9	Hydroquinone
107-13-1	Acrylonitrile	542-75-6	1,3-Dichloropropene	78-59-1	Isophorone
107-05-1	Allyl chloride	62-73-7	Dichlorvos	58-89-9	Lindane (all isomers)
92-67-1	4-Aminobiphenyl	111-42-2	Diethanolamine	108-31-6	Maleic anhydride
62-53-3	Aniline	121-69-7	N,N-Diethyl aniline (N,N-Dimethylaniline)	67-56-1	Methanol
90-04-0	o-Anisidine	64-67-5	Diethyl sulfate	72-43-5	Methoxychlor
1332-21-4	Asbestos	119-90-4	3,3-Dimethoxybenzidine	74-83-9	Methyl bromide (Bromomethane)
71-43-2	Benzene (including benzene from gasoline)	60-11-7	Dimethyl aminoazobenzene	74-87-3	Methyl chloride (Chloromethane)
92-87-5	Benidine	119-93-7	3,3'-Dimethyl benzidine	71-55-6	Methyl chloroform (1,1,1-Trichloroethane)
98-07-7	Benzotrichloride	79-44-7	Dimethyl carbamoyl chloride	78-93-3	Methyl ethyl ketone (2-Butanone)
100-44-7	Benzyl chloride	68-12-2	Dimethyl formamide	60-34-4	Methyl hydrazine
92-52-4	Biphenyl	57-14-7	1,1-Dimethyl hydrazine	74-88-4	Methyl iodide (Iodomethane)
117-81-7	Bis(2-ethylhexyl) phthalate (DEHP)	131-11-3	Dimethyl phthalate	108-10-1	Methyl isobutyl ketone (Hexone)
542-88-1	Bis(chloromethyl)ether	77-78-1	Dimethyl sulfate	624-83-9	Methyl isocyanate
75-25-2	Bromoform	534-52-1	4,6-Dinitro-o-cresol, and salts	80-62-6	Methyl methacrylate
106-99-0	1,3-Butadiene	51-28-5	2,4-Dinitrophenol	1634-04-4	Methyl tert butyl ether
156-62-7	Calcium cyanamide	121-14-2	2,4-Dinitrotoluene	101-14-4	4,4'-Methylene bis(2-chloroaniline)
133-06-2	Captan	123-91-1	1,4-Dioxane (1,4-Diethyleneoxide)	75-09-2	Methylene chloride (Dichloromethane)
63-25-2	Carbaryl	122-66-7	1,2-Diphenylhydrazine	101-68-8	Methylene diphenyl diisocyanate (MDI)
75-15-0	Carbon disulfide	106-89-8	Epichlorohydrin (1-Chloro- 2,3-epoxypropane)	101779	4,4'-Methylenedianiline
56-23-5	Carbon tetrachloride	106-88-7	1,2-Epoxybutane	91-20-3	Naphthalene
463-58-1	Carbonyl sulfide	140-88-5	Ethyl acrylate	98-95-3	Nitrobenzene
120-80-9	Catechol	100-41-4	Ethyl benzene	92-93-3	4-Nitrobiphenyl
133-90-4	Chloramben	51-79-6	Ethyl carbamate (Urethane)	100-02-7	4-Nitrophenol
57-74-9	Chlordane	75-00-3	Ethyl chloride (Chloroethane)	79-46-9	2-Nitropropane
7782-50-5	Chlorine	106-93-4	Ethylene dibromide (Dibromoethane)	684-93-5	N-Nitroso-N-methylurea
79-11-8	Chloroacetic acid	107-06-2	Ethylene dichloride (1,2-Dichloroethane)	62-75-9	N-Nitrosodimethylamine
532-27-4	2-Chloroacetophenone	107-21-1	Ethylene glycol	59-89-2	N-Nitrosomorpholine
108-90-7	Chlorobenzene	151-56-4	Ethylene imine (Aziridine)	56-38-2	Parathion
510-15-6	Chlorobenzilate	75-21-8	Ethylene oxide	82-68-8	Pentachloronitrobenzene (Quintobenzene)
67-66-3	Chloroform	96-45-7	Ethylene thiourea	87-86-5	Pentachlorophenol
107-30-2	Chloromethyl methyl ether	75-34-3	Ethylidene dichloride (1,1-Dichloroethane)	108-95-2	Phenol
126-99-8	Chloroprene	50-00-0	Formaldehyde	106-50-3	p-Phenylenediamine
1319-77-3	Cresols/Cresylic acid (isomers and mixture)	76-44-8	Heptachlor	75-44-5	Phosgene
95-48-7	o-Cresol	118-74-1	Hexachlorobenzene	7803-51-2	Phosphine
108-39-4	m-Cresol	87-68-3	Hexachlorobutadiene		
106-44-5	p-Cresol	77-47-4	Hexachlorocyclopenta-diene		
98-82-8	Cumene				
94-75-7	2,4-D, salts and esters				

Table 2  
HAPs Defined in Section 112 of the CAA Amendments of 1990 (cont)

CAS#	CHEMICAL NAME	CAS#	CHEMICAL NAME	CAS#	CHEMICAL NAME
7723-14-0	Phosphorus	108-88-3	Toluene	108-38-3	m-Xylenes
85-44-9	Phthalic anhydride	95-80-7	2,4-Toluene diamine	106-42-3	p-Xylenes
1336-36-3	Polychlorinated biphenyls (Aroclors)	584-84-9	2,4-Toluene diisocyanate	[none]	Antimony Compounds
1120-71-4	1,3-Propane sultone	95-53-4	o-Toluidine	[none]	Arsenic Compounds (inorganic including arsine)
57-57-8	beta-Propiolactone	8001-35-2	Toxaphene (chlorinated camphene)	[none]	Beryllium Compounds
123-38-6	Propionaldehyde	120-82-1	1,2,4-Trichlorobenzene	[none]	Cadmium Compounds
114-26-1	Propoxur (Baygon)	79-00-5	1,1,2-Trichloroethane	[none]	Chromium Compounds
78-87-5	Propylene dichloride (1,2-Dichloropropane)	79-01-6	Trichloroethylene	[none]	Cobalt Compounds
75-56-9	Propylene oxide	95-95-4	2,4,5-Trichlorophenol	[none]	Coke Oven Emissions
75-55-8	1,2-Propylenimine (2-Methyl aziridine)	88-06-2	2,4,6-Trichlorophenol	[none]	Cyanide Compounds <sup>a</sup>
91-22-5	Quinoline	121-44-8	Triethylamine	[none]	Glycol ethers <sup>b</sup>
106-51-4	Quinone (p-Benzoquinone)	1582-09-8	Trifluralin	[none]	Lead Compounds
100-42-5	Styrene	540-84-1	2,2,4-Trimethylpentane	[none]	Manganese Compounds
96-09-3	Styrene oxide	108-05-4	Vinyl acetate	[none]	Mercury Compounds
1746-01-6	2,3,7,8-Tetrachlorodi-benzo-p-dioxin	593-60-2	Vinyl bromide	[none]	Fine mineral fibers <sup>c</sup>
79-34-5	1,1,2,2-Tetrachloroethane	75-01-4	Vinyl chloride	[none]	Nickel Compounds
127-18-4	Tetrachloroethylene (Perchloroethylene)	75-35-4	Vinylidene chloride (1,1-Dichloroethylene)	[none]	Polycyclic Organic Matter <sup>d</sup>
7550-45-0	Titanium tetrachloride	1330-20-7	Xylenes (mixed isomers)	[none]	Radionuclides (including radon) <sup>e</sup>
		95-47-6	o-Xylenes	[none]	Selenium Compounds

NOTE: For all listings above which contain the word “compounds” and for glycol ethers, the following applies: Unless otherwise specified, these listings are defined as including any unique chemical substance that contains the named chemical (i.e., antimony, arsenic, etc.) as part of that chemical’s infrastructure.

a X’CN where X = H’ or any other group where a formal dissociation can occur. For example KCN or Ca(CN)<sub>2</sub>.

b On January 12, 1999 (64 FR 1780), EPA proposed to modify the definition of glycol ethers to exclude surfactant alcohol ethoxylates and their derivatives (SAED). On August 2, 2000 (65 FR 47342), EPA published the final action. This action deletes each individual compound in a group called the surfactant alcohol ethoxylates and their derivatives (SAED) from the glycol ethers category in the list of hazardous air pollutants (HAP) established by section 112(b)(1) of the Clean Air Act (CAA). EPA also made conforming changes in the definition of glycol ethers with respect to the designation of hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

“The following definition of the glycol ethers category of hazardous air pollutants applies instead of the definition set forth in 42 U.S.C. 7412(b)(1), footnote 2: Glycol ethers include mono- and di-ethers of ethylene glycol, diethylene glycol, and triethylene glycol R-(OCH<sub>2</sub>CH<sub>2</sub>)<sub>n</sub>-OR’

Where:

n= 1, 2, or 3

R= alkyl C7 or less, or phenyl or alkyl substituted phenyl

R’= H, or alkyl C7 or less, or carboxylic acid ester, sulfate, phosphate, nitrate, or sulfonate.

c Includes mineral fiber emissions from facilities manufacturing or processing glass, rock, or slag fibers (or other mineral derived fibers) of average diameter 1 micrometer or less. (Currently under review.)

d Includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100°C. (Currently under review.)

e A type of atom which spontaneously undergoes radioactive decay.

Table 3  
Source Categories With MACT Standards

Source Category	Federal Register Citation	Source Category	Federal Register Citation
<b>Fuel Combustion</b>		Marine Vessel Loading Operations	60 FR 48399(F) 9/19/95
Coal- and Oil-fired Electric Utility Steam Generating Units	65 FR 79825(N) 12/20/00	Organic Liquids Distribution (Non-Gasoline)	*
Combustion Turbines	*	<b>Surface Coating Processes</b>	
Engine Test Facilities	*	Aerospace Industries	60 FR 45956(F) 9/1/15
Industrial Boilers	*	Auto and Light Duty Truck	*
Institutional/Commercial Boilers	*	Flat Wood Paneling	64 FR 63025(N) 11/18/99
Process Heaters	*	Large Appliance	65 FR 81134(P) 12/22/00
Reciprocating Internal Combustion Engines*	*	Magnetic Tapes	59 FR 64580(F) 12/15/94
Rocket Testing Facilities	*	Manufacture of Paints, Coatings, and Adhesives	*
<b>Non-Ferrous Metals Processing</b>		Metal Can	*
Primary Aluminum Production	62 FR 52383(F) 10/7/97	Metal Coil	65 FR 44616(P) 7/18/00
Primary Copper Smelting	63 FR 19582(P) 4/20/98	Metal Furniture	*
Primary Lead Smelting	64 FR 30194(F) 6/4/99	Miscellaneous Metal Parts and Products	*
Primary Magnesium Refining	*	Paper and Other Webs	65 FR 55332(P) 9/13/00
Secondary Aluminum Production	65 FR 15689(F) 3/23/00	Plastic Parts and Products	*
Secondary Lead Smelting	60 FR 32587(F) 6/23/95	Printing, Coating, and Dyeing of Fabrics	*
<b>Ferrous Metals Processing</b>		Printing/Publishing	61 FR 27132(F) 5/30/96
Coke Ovens: Charging, Top Side, and Door Leaks	58 FR 57898(F) 10/27/93	Shipbuilding and Ship Repair	60 FR 64330(F) 12/16/96
Coke Ovens: Pushing, Quenching and Battery Stacks	66 FR 35327(P) 7/3/01	Wood Building Products	*
<b>Ferroalloys Production</b>		Wood Furniture	60 FR 62930(F) 12/7/95
Silicomanganese and Ferromanganese	64 FR 27450(F) 5/20/00	<b>Waste Treatment and Disposal</b>	
Integrated Iron and Steel Manufacturing	66 FR 36835(P) 7/13/01	Hazardous Waste Incineration	64 FR 52828(F) 9/30/99
Iron Foundries	*	Municipal Solid Waste Landfills	65 FR 66672(P) 11/7/00
Steel Foundries	*	Off-Site Waste and Recovery Operations	61 FR 34140(F) 7/1/96
Steel Pickling–HCl Process Facilities and Hydrochloric Acid Regeneration Plants	64 FR 33202(F) 6/22/99	Publicly Owned Treatment Works	64 FR 57572(F) 10/26/99
<b>Mineral Products Processing</b>		Site Remediation	*
Asphalt Processing	*	<b>Agricultural Chemicals Production</b>	
Asphalt Roofing Manufacturing	*	Pesticide Active Ingredient Production	64 FR 33549(F) 6/23/99
Asphalt/Coal Tar Application–Metal Pipes	*	<b>Fibers Production Processes</b>	
Clay Products Manufacturing	*	Acrylic Fibers/Modacrylic Fibers	64 FR 34853(F) 6/30/99
Lime Manufacturing	*	Spandex Production	65 FR 76408(P) 12/6/00
Mineral Wool Production.	64 FR 29490(F) 6/1/99	<b>Food and Agriculture Processes</b>	
Portland Cement Manufacturing	64 FR 31897(F) 6/14/99	Manufacturing of Nutritional Yeast	66 FR 27876(F) 5/21/01
Refractories Manufacturing	*	Solvent Extraction for Vegetable Oil Production	66 FR 19006(F) 4/12/01
Taconite Iron Ore Processing	*	Vegetable Oil Production	66 FR 8220(N) 1/30/01
Wool Fiberglass Manufacturing	64 FR 31695(F) 6/14/99	<b>Pharmaceutical Production Processes</b>	
<b>Petroleum and Natural Gas Production and Refining</b>		Pharmaceuticals Production	66 FR 40121(F) 6/1/99
Oil and Natural Gas Production	64 FR 32610(F) 6/17/99	<b>Polymers and Resins Production</b>	
Natural Gas Transmission and Storage	64 FR 32610(F) 6/17/99	Acetal Resins Production	64 FR 34853(F) 6/30/99
Petroleum Refineries–Catalytic Cracking Units, Catalytic Reforming Units, and Sulfur Recovery Units	63 FR 48890(P) 9/11/98	Acrylonitrile-Butadiene-Styrene Production	61 FR 48208(F) 9/12/96
Petroleum Refineries–Other Sources Not Distinctly Listed	60 FR 43244(F) 8/18/95	Alkyd Resins Production	*
<b>Liquids Distribution</b>		Amino Resins Production	65 FR 3275(F) 1/20/00
Gasoline Distribution (Stage 1)	59 FR 64303(F) 12/14/94	Boat Manufacturing	66 FR 44218(F) 8/22/01
		Butyl Rubber Production	61 FR 46906(F) 9/5/96
		Cellulose Ethers Production	65 FR 52166(P) 8/28/00
		Epichlorohydrin Elastomers Production	61 FR 46906(F) 9/5/96

Table 3  
Source Categories With MACT Standards (cont.)

Source Category	Federal Register Citation	Source Category	Federal Register Citation
Epoxy Resins Production	60 FR 12670(F) 3/8/95	Quaternary Ammonium Compounds Production	*
Ethylene-Propylene Rubber Production	61 FR 46906(F) 9/5/96	Synthetic Organic Chemical Manufacturing	59 FR 19402(F) 4/22/94
Flexible Polyurethane Foam Production	63 FR 53980(F) 10/7/98		
Hypalon (tm) Production	61 FR 46906(F) 9/5/96	<b>Miscellaneous Processes</b>	
Maleic Anhydride Copolymers Production	*	Benzyltrimethylammonium Chloride Production	*
Methyl Methacrylate-Acrylonitrile Butadiene-Styrene Production	61 FR 48208(F) 9/12/96	Carbonyl Sulfide Production	*
Methyl Methacrylate-Butadiene-Styrene Terpolymers Production	61 FR 48208(F) 9/12/96	Chelating Agents Production	*
Neoprene Production	61 FR 46906(F) 9/5/96	Chlorinated Paraffins Production	*
Nitrile Butadiene Rubber Production	61 FR 46906(F) 9/5/96	Chromic Acid Anodizing	60 FR 04948(F) 1/25/95
Nitrile Resins Production	61 FR 48208(F) 9/12/96	Combustion Sources at Kraft, Soda, and Sulfite Pulp and Paper Mills	66 FR 3180(F) 1/12/01
Non-Nylon Polyamides Production	60 FR 12670(F) 3/8/95	Commercial Dry Cleaning (Perchloroethylene)–Transfer Machines	58 FR 49354(F) 9/22/93
Phenolic Resins Production	65 FR 3275(F) 1/20/00	Commercial Sterilization Facilities	59 FR 62585(F) 12/6/94
Polybutadiene Rubber Production	61 FR 46906(F) 9/5/96	Decorative Chromium Electroplating	60 FR 04948(F) 1/25/95
Polycarbonates Production	64 FR 34853(F) 6/30/99	Ethylidene Norbornene Production	*
Polyester Resins Production	*	Explosives Production	*
Polyether Polyols Production	64 FR 29420(F) 6/1/99	Flexible Polyurethane Foam Fabrication Operations	66 FR 41718(P) 8/8/01
Polyethylene Terephthalate Production	61 FR 48208(F) 9/12/96	Halogenated Solvent Cleaners	59 FR 61801(F) 12/2/94
Polymerized Vinylidene Chloride Production	*	Hard Chromium Electroplating	60 FR 04948(F) 1/25/95
Polymethyl Methacrylate Resins Production	*	Hydrazine Production	*
Polystyrene Production	61 FR 48208(F) 9/12/96	Industrial Cleaning (Perchloroethylene)–Dry-to-Dry machines	58 FR 49354(F) 9/22/93
Polysulfide Rubber Production	61 FR 46906(F) 9/5/96	Industrial Dry Cleaning (Perchloroethylene)–Transfer Machines	58 FR 49354(F) 9/22/93
Polyvinyl Acetate Emulsions Production	*	Industrial Process Cooling Towers	59 FR 46339(F) 9/8/94
Polyvinyl Alcohol Production	*	Leather Finishing Operations	67 FR 9155(F) 2/27/02
Polyvinyl Butyral Production	*	Miscellaneous Viscose Processes	65 FR 52166(F) 8/28/00
Polyvinyl Chloride and Copolymers Production	65 FR 76958(P) 12/8/00	OBPA/1,3-Diisocyanate Production	*
Reinforced Plastic Composites Production	66 FR 40324(P) 8/2/01	Paint Stripping Operations	*
Styrene-Acrylonitrile Production	61 FR 48208(F) 9/12/96	Photographic Chemicals Production	*
Styrene-Butadiene Rubber and Latex Production	61 FR 46906(F) 9/5/96	Phthalate Plasticizers Production	*
		Plywood and Composite Wood Products	*
<b>Production of Inorganic Chemicals</b>		Pulp and Paper Production	65 FR 80755(F) 12/22/00
Ammonium Sulfate Production–Caprolactam By-Product Plants	*	Rubber Chemicals Manufacturing	*
Carbon Black Production	65 FR 76408(P) 12/6/00	Rubber Tire Manufacturing	63 FR 62414(P) 10/18/00
Chlorine Production	*	Semiconductor Manufacturing	*
Cyanide Chemicals Manufacturing	65 FR 76408(P) 12/6/00	Symmetrical Tetrachloropyridine Production	*
Fumed Silica Production	64 FR 63025(N) 11/18/99		
Hydrochloric Acid Production	*	Tetrahydrobenzaldehyde Manufacture	63 FR 26078(F) 5/21/98
Hydrogen Fluoride Production	64 FR 34853(F) 6/30/99	Wet-Formed Fiberglass Mat Production	65 FR 34277(P) 5/26/00
Phosphate Fertilizers Production	64 FR 31358(F) 6/10/99		
Phosphoric Acid Manufacturing	64 FR 31358(F) 6/10/99		
<b>Production of Organic Chemicals</b>			
Ethylene Processes	65 FR 76408(P) 12/6/00		

This table contains final rules (F), proposed rules (P), and notices (N) promulgated as of February 2002. It does not identify corrections or clarifications to rules. An \* denotes sources required by Section 112 of the CAA to have MACT standards by 11/15/00 for which proposed rules are being prepared but have not yet been published.

## D. Title V Operating Permits

For many facilities, the new federal operating permit program established under Title V of the CAA will cover all sources of airborne emissions.<sup>6</sup> Generally, it requires a permit for any facility emitting or having the potential to emit more than 100 tpy of any air pollutants though lower thresholds apply in non-attainment areas.<sup>7</sup> Permits are also required for all sources subject to MACT or NSPS standards, the Title IV acid rain program, and new source review permits under Parts C and D of Title V. All airborne emission requirements that apply to an industrial facility, including emission limitations, operational requirements, monitoring requirements, and reporting requirements, will be incorporated in its operating permit. A Title V permit provides a vehicle for ensuring that existing air quality control requirements are appropriately applied to facility emission units.

Under the new program, operating permits that meet federal requirements will generally be issued by state agencies. In developing individual permits, states can determine whether to explicitly apply emission limitations and controls to waste management units. See Section F of this chapter (A Decision Guide to Applicable CAA Requirements), and consult with federal, state, and local air program staff to determine if your waste management unit is subject to airborne emission limits and controls under CAA regulations. Listings of EPA regional and state air pollution control agencies can be obtained from the States and Territorial Air Pollution Program Administrators (STAPPA)

& Association of Local Air Pollution Control Officials (ALAPCO). STAPPA/ALAPCO's Web site is <[www.cleanairworld.org/scripts/us\\_temp.asp?id=307](http://www.cleanairworld.org/scripts/us_temp.asp?id=307)>.

## E. Federal Airborne Emission Regulations for Solid Waste Management Activities

While EPA has not established airborne emission regulations for industrial waste management units under RCRA, standards developed for hazardous waste management units and municipal solid waste landfills (MSWLFs) can serve as a guide in evaluating the need for controls at specific units.

### 1. Hazardous Waste Management Unit Airborne Emission Regulations

Under Section 3004(n) of RCRA, EPA established standards for the monitoring and control of airborne emissions from hazardous waste treatment, storage, and disposal facilities. Subparts AA, BB, and CC of 40 CFR Part 264 address VOC releases from process vents, equipment leaks, tanks, surface impoundments, and containers. Summaries of Subparts AA, BB, and CC are provided in the text box on the next page.

### 2. Municipal Solid Waste Landfill Airborne Emission Regulations

On March 12, 1996, EPA promulgated airborne emission regulations for large new and existing MSWLFs.<sup>8</sup> These regulations apply to all new MSWLFs constructed or modified on

<sup>6</sup> Federal Operating Permit Regulations were promulgated as 40 CFR Part 71 on July 1, 1996 and amended on February 19, 1999 to cover permits in Indian Country and states without fully approved Title V programs.

<sup>7</sup> Under CAA Section 302(g), "air pollutant" is defined as any pollutant agent or combination of agents, including any physical, chemical, biological, or radioactive substance or matter which is emitted into or otherwise enters the ambient air.

<sup>8</sup> 61 FR 9905; March 12, 1996, codified at 40 CFR Subpart WWW and CC (amended 63 FR 32750, June 16, 1998).

or after May 30, 1991, and to existing landfills that have accepted waste on or after November 8, 1987. In addition to methane, MSWLFs potentially emit non-methane organic compounds (NMOCs) in the gases generated during waste decomposition, as well as in combustion of the gases in control devices, and from other sources, such as dust from vehicle traffic and emissions from leachate treatment facilities or maintenance shops. Under the regulations, any affected MSWLF that emits more than 50 Mg/yr (55 tpy) of NMOCs is required to install controls.

Best demonstrated technology requirements for both new and existing municipal landfills prescribe installation of a well-designed and well-operated gas collection system and a control device. The collection system should be designed to allow expansion for new cells that require controls. The control device (presumed to be a combustor) must demonstrate either an NMOC reduction of 98 percent by weight in the collected gas or an outlet NMOC concentration of no more than 20 parts per million by volume (ppmv).

### 3. *Offsite Waste and Recovery Operations NESHAP*

On July 1, 1996, EPA established standards for offsite waste and recovery operations

## **Summary of Airborne Emission Regulations for Hazardous Waste Management Units**

**Subpart AA** regulates organic emissions from process vents associated with distillation, fractionation, thin film evaporation, solvent extraction, and air or stream stripping operations (40 CFR §§264.1030-1036). Subpart AA only applies to these types of units managing hazardous waste streams with organic concentration levels of at least 10 parts per million by weight (ppmw). Subpart AA regulations require facilities with covered process vents to either reduce total organic emissions from all affected process vents at the facility to below 3 lb/h and 3.1 tons/yr, or reduce emissions from all process vents by 95 percent through the use of a control device, such as a closed-vent system, vapor recovery unit, flare, or other combustion unit.

**Subpart BB** sets inspection and maintenance requirements for equipment, such as valves, pumps, compressors, pressure relief devices, sampling connection systems, open-ended valves or lines, flanges, or control devices that contain or contact hazardous wastes with organic concentrations of at least 10 percent by weight (40 CFR §§264.1050-1065). Subpart BB does not establish numeric criteria for reducing emissions, it simply establishes monitoring, leak detection, and repair requirements.

**Subpart CC** establishes controls on tanks, surface impoundments, and containers in which hazardous waste has been placed (40 CFR §§264.1080-1091). It applies only to units containing hazardous waste with an average organic concentration greater than 500 ppmw. Units managing hazardous waste that has been treated to reduce the concentrations of organics by 95 percent are exempt. Non-exempt surface impoundments must have either a rigid cover or, if wastes are not agitated or heated, a floating membrane cover. Closed vent systems are required to control the emissions from covered surface impoundments. These control systems must achieve the same 95 percent emission reductions described above under Subpart AA.

(OSWRO) that emit HAPs.<sup>9</sup> To be covered by OSWRO, a facility must emit or have the potential to emit at least 10 tpy of any single HAP or at least 25 tpy of any combination of HAPs. It must receive waste, used oil, or used solvents from off site that contain one or more HAPs.<sup>10</sup> In addition, the facility must operate one of the following: a hazardous waste treatment, storage, or disposal facility; RCRA-exempt hazardous wastewater treatment operation; nonhazardous wastewater treatment facility other than a publicly owned treatment facility; or a RCRA-exempt hazardous waste recycling or reprocessing operation, used solvent recovery operation, or used oil recovery operation.

OSWRO contains MACT standards to reduce HAP emissions from tanks, surface impoundments, containers, oil-water separators, individual drain systems, other material conveyance systems, process vents, and equipment leaks. For example, OSWRO establishes two levels of air emission controls for tanks depending on tank design capacity and the maximum organic HAP vapor pressure of the offsite material in the tank. For process vents, control devices must achieve a minimum of 95 percent organic HAP emission control. To control HAP emissions from equipment leaks, the facility must implement leak detection and repair work practices and equipment modifications for those equipment components containing or contacting offsite waste having a total organic HAP concentration greater than 10 percent by weight (see 40 CFR 63.683(d) cross ref. to 40 CFR 63.680 (c) (3)).

## F. A Decision Guide to Applicable CAA Requirements

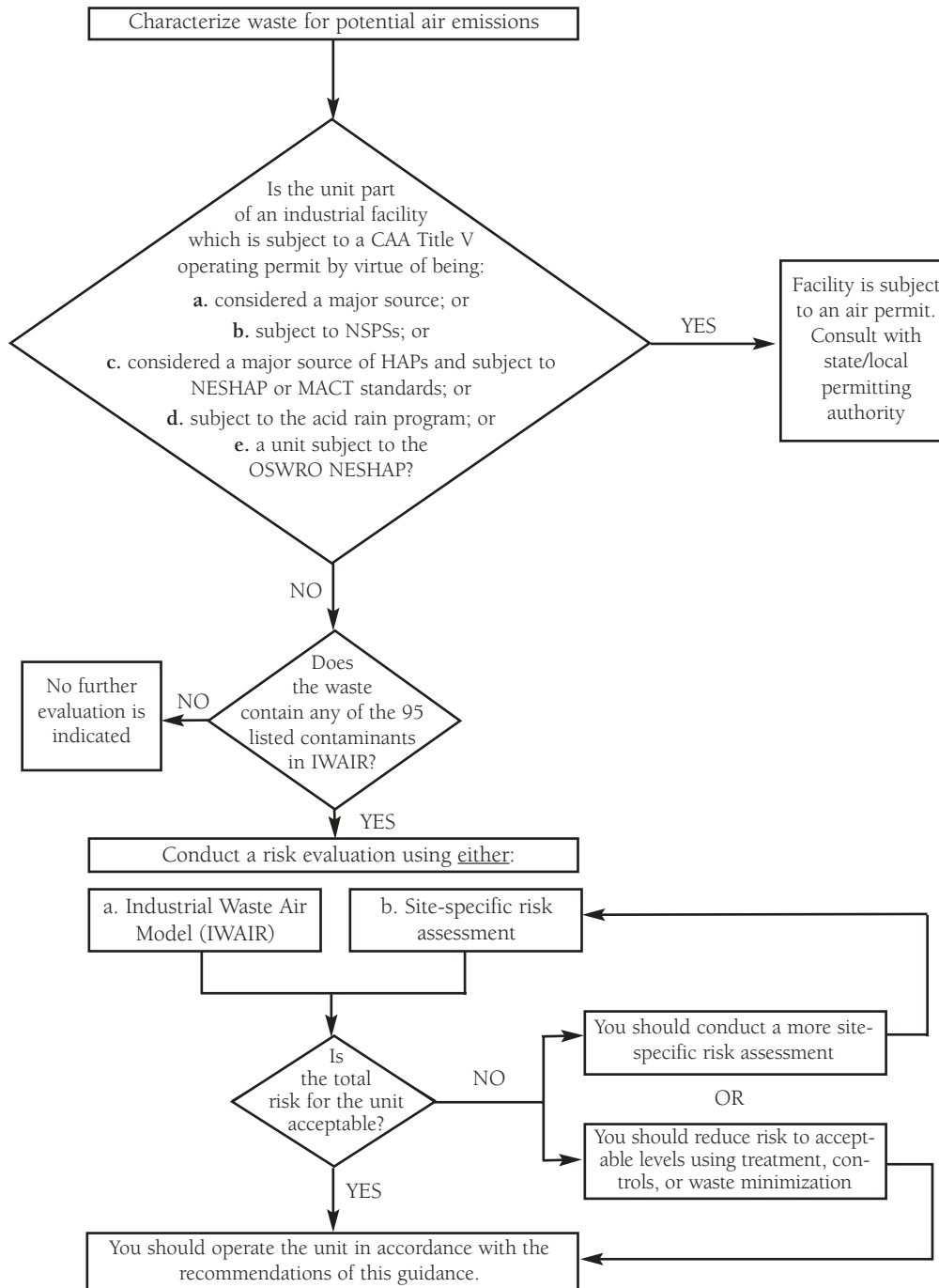
The following series of questions, summarized in Figure 1, is designed to help you identify CAA requirements that might apply to a facility. This will not give you definitive answers, but can provide a useful starting point for consultation with federal, state, or local permitting authorities to determine which requirements apply to a specific facility and whether such requirements address waste management units at the facility. If a facility is clearly not subject to CAA requirements, assessing potential risks from VOC emissions at a waste management unit using the IWAIR or a site-specific risk assessment is recommended.

The following steps provide a walk through of this evaluation process:

1. *Determining Emissions From the Unit*
  - a) Determining VOC's present in the waste (waste characterization). Then assume all the VOC's are emitted from the unit, or
  - b) Estimating emissions using an emissions model. This also requires waste characterization. The CHEMDAT8 model is a logical model for these types of waste units. You can use the EPA version on the Internet or the one contained in the IWAIR modeling tool for the Guide, or
  - c) Measuring emissions from the unit. While this is the most resource intensive alternative, measured data will provide the most accurate information.

<sup>9</sup> 61 FR 34139; July 1, 1996, as amended, 64 FR 38970 (July 20, 1999) and 66 FR 1266 (January 8, 2001).

<sup>10</sup> OSWRO identified approximately 100 HAPs to be covered. This HAP list is a subset of the CAA Section 112 list.

**Figure 1. Evaluating VOC Emission Risk**

## 2. *Is the Waste Management Unit Part of an Industrial Facility That Is Subject to a CAA Title V Operating Permit?*

A facility is subject to a Title V operating permit if it is considered a major source of air pollutants, or is subject to a NSPS, NESHAP, or Title IV acid rain provision.<sup>11</sup> As part of the permitting process, the facility should develop an emissions inventory. Some states have additional permitting requirements. If a facility is subject to a Title V operating permit, all airborne emission requirements that apply to an industrial facility, including emission limitations as well as operational, monitoring, and reporting requirements, will be incorporated in its operating permit. You should consult with appropriate federal, state, and local air program staff to determine whether your waste management unit is subject to air emission limits and controls.<sup>12</sup>

If you answer yes to any of the questions in items a. through e. below, the facility is subject to a Title V operating permit. Consult with the appropriate federal, state, and/or local permitting authority.

Whether or not emissions from waste management unit(s) will be specifically addressed through the permit process depends on a number of factors, including the type of facility and CAA requirements and state permitting resources and priorities. It is prudent, when there are no applicable air permit requirements, to assess whether there might be risks associated with waste management units and to address these potential risks.

If you answer no to all the questions below, continue to Step 3.

**Stationary source** is defined as any building, structure, facility, or installation that emits or may emit any regulated air pollutant or any hazardous air pollutant listed under Section 112 (b) of the Act.

An **air pollutant** is defined as any air pollution agent or combination of agents, including a physical, chemical, biological, radioactive substance or matter which is emitted into or otherwise enters the ambient air.

### a. *Is the facility considered a major source?*

If the facility meets any of the following three definitions, it is considered a major source (under 40 CFR § 70.2) and subject to Title V operating permit requirements.

- i. Any **stationary source** or group of stationary sources that emits or has the potential to emit at least 100 tpy of any **air pollutant**.
- ii. Any stationary source or group of stationary sources that emits or has the potential to emit at least 10 tpy of any single HAP or at least 25 tpy of any combination of HAPs.
- iii. A stationary source or group of stationary sources subject to the nonattainment area provisions of CAA Title I that emits, or has the potential to emit, above the threshold values for its nonattainment area category. The nonattainment area category and the source's emission levels for VOCs and NO<sub>x</sub>, particulate matter (PM-10), and carbon monoxide (CO) determine whether the stationary source meets the definition of a "major source." For nonattainment areas, stationary sources are considered "major

<sup>11</sup> EPA can designate additional source categories subject to Title V operating permit requirements.

<sup>12</sup> Implementation of air emission controls can generate new residual waste. Ensure that these wastes are managed appropriately, in compliance with state requirements and consistent with the Guide.

sources” if they emit or have the potential to emit at least the levels found in Table 4 below.

If yes, the facility is subject to a Title V operating permit. Consult with the appropriate federal, state, and/or local permitting authority.

If no, continue to determine whether the facility is subject to a Title V operating permit.

*b. Is the facility subject to NSPSs?*

Any stationary source subject to a standard of performance under 40 CFR Part 60 is subject to NSPS. (A list of NSPSs can be found in Table 1 above.)

If yes, the facility is subject to a Title V operating permit. Consult with the appropriate federal, state, and/or local permitting authority.

If no, continue to determine if the facility is subject to a Title V operating permit.

*c. Is the facility a major source of HAPs as defined by Section 112 of CAA and subject to a NESHAP or MACT standard?*

Under Title V of CAA, an operating permit is required for all facilities subject to a MACT standard. NESHAPs or MACT standards are national standards to reduce HAP emissions. Each MACT standard specifies particular operations, processes, and/or wastes that are covered. EPA has identified approximately 170 source categories and subcategories that are or will be subject to MACT standards. (Table 3 above lists the source categories for which EPA is required to promulgate MACT standards.) MACT standards have been or will be promulgated for all major source categories of HAPs and for certain area sources.

If yes, the facility should be permitted under CAA Title V. Consult with the appropriate federal, state, and/or local permitting authority.

If no, continue to determine if the facility must obtain a Title V operating permit.

*d. Is the facility subject to the acid rain program under Title IV of CAA?*

If a facility, such as a fossil-fuel fired power plant, is subject to emission reduction requirements or limitations under the acid rain program, it must obtain a Title V operating permit (40 CFR § 72.6). The acid rain program focuses on the reduction of annual sulfur dioxide and nitrogen oxides emissions.

Table 4.  
Major Source Determination in Nonattainment Areas

Nonattainment Area Category <sup>13</sup>	VOCs or NO <sub>x</sub>	PM-10	CO
Marginal or Moderate	100 tpy	100 tpy	100 tpy
Serious	50 tpy	70 tpy	50 tpy
Severe	25 tpy	—	—
Extreme	10 tpy	—	—

<sup>13</sup> The nonattainment categories are based upon the severity of the area's pollution problems. The four categories for VOCs and NO<sub>x</sub> range from Moderate to Extreme. Moderate areas are the closest to meeting the attainment standard, and require the least amount of action. Nonattainment areas with more serious air quality problems must implement various control measures. The worse the air quality, the more controls areas will have to implement. PM-10 and CO have only two categories, Moderate and Serious.

A **major source** under Title III is defined as any stationary source or group of stationary sources that emits or has the potential to emit at least 10 tpy of any single hazardous air pollutant (HAP) or at least 25 tpy of any combination of HAPs.

An **area source** is any stationary source which is not a major source but which might be subject to controls. Area sources represent a collection of facilities and emission points for a specific geographic area. Most area sources are small, but the collective volume of large numbers of facilities can be a concern in densely developed areas, such as urban neighborhoods and industrial areas. Examples of areas sources subject to MACT standards include chromic acid anodizing, commercial sterilization facilities, decorative chromium electroplating, hard chromium electroplating, secondary lead smelting, and halogenated solvent cleaners.

**HAPs** are any of the 188 pollutants listed in Section 112(b) of CAA. (Table 2 above identifies the 188 HAPs.)

If yes, the facility must obtain a Title V permit. Consult with the appropriate federal, state, and/or local permitting authority.

When you consult with the appropriate permitting authority, it is important to clarify whether waste management units at the facility are addressed by the requirements. If waste management units will not be addressed through the permit process, you should evaluate VOC emission risks.

If no, continue to determine if the facility must obtain a Title V operating permit.

- e. *Is the waste management unit subject to the OSWRO NESHAP? This is just an example of the types of questions you will need to answer to determine whether a NESHAP or MACT standard covers your facility.*

To be covered by the OSWRO standards, your facility must meet all these conditions:

- i. Be identified as a major source of HAP emissions.
- ii. Receive waste, used oil, or used solvents (subject to certain exclusions, 40 CFR 63.680 (b) (2)) from off site that contain one or more HAPs.<sup>14</sup>
- iii. Operate one of the following six types of waste management or recovery operations (see 40 CFR 63.680 (a) (2)):
  - Hazardous waste treatment, storage, or disposal facility.
  - RCRA-exempt hazardous wastewater treatment operation.
  - Nonhazardous wastewater treatment facility other than a publicly owned treatment facility.
  - RCRA-exempt hazardous waste recycling or reprocessing operation.
  - Used solvent recovery operations.
  - Used oil recovery operations.

If yes, the unit should be covered by the OSWRO standards and Title V permitting. Consult with the appropriate federal, state, and/or local permitting authority.

If no, it is highly recommended that you conduct an air risk evaluation as set out in step 3.

<sup>14</sup> OSWRO identified approximately 100 HAPs to be covered. This HAP list is a subset of the CAA Section 112 list.

3. *Conducting a Risk Evaluation Using One of the Following Options:*
  - a. Using IWAIR included with the Guide if your unit contains any of the 95 contaminants that are covered in the model.
  - b. Initiating a site-specific risk assessment for individual units. Total all target constituents from all applicable units and consider emissions from other sources at the facility as well.

## II. Assessing Risk

Air acts as a medium for the transport of airborne contamination and, therefore, constitutes an exposure pathway of potential concern. Models that can predict the fate and transport of chemical emissions in the atmosphere can provide an important tool for evaluating and protecting air quality. The Industrial Waste Air Model (IWAIR) included in the Guide was developed to assist facility managers, regulatory agency staff, and the public in evaluating inhalation risks from waste management unit emissions. Although IWAIR is simple to use, it is still essential to understand the basic concepts of atmospheric modeling to be able to interpret the results and understand the nature of any uncertainties. The purpose of this section is to provide general information on the atmosphere, chemical transport in the atmosphere, and the risks associated with inhalation of chemicals so you can understand important factors to consider when performing a risk assessment for the air pathway.

From a risk perspective, because humans are continuously exposed to air, the presence of chemicals in air is important to consider in any type of assessment. If chemicals build up to high concentrations in a localized area,

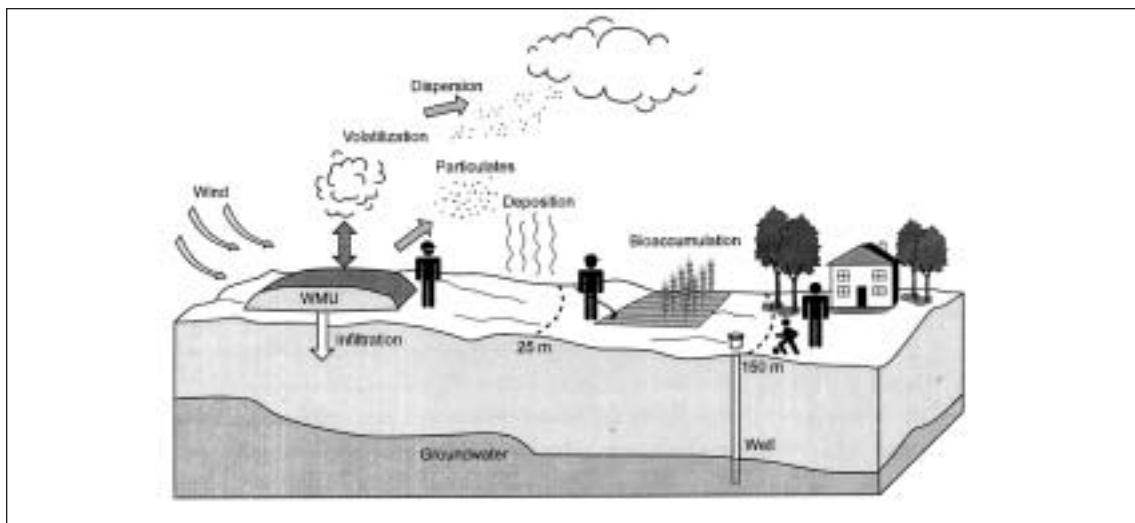
human health can be compromised. The concentration of chemicals in a localized area and the resulting air pollution that can occur in the atmosphere is dependent upon the quantity and the rate of the emissions from a source and the ability of the atmosphere to disperse the chemicals. Both meteorological and geographic conditions in a local area will influence the emission rate and subsequent dispersion of a chemical. For example, the meteorologic stability of the atmosphere, a factor dependent on air temperature, influences whether the emission stream will rise and mix with a larger volume of air (resulting in the dilution of pollutants) or if the emissions stream will remain close to the ground. Figure 2 is a conceptual diagram of a waste site illustrating potential paths of human exposure through air.

### A. Assessing Risks Associated with Inhalation of Ambient Air

In any type of risk assessment, there are basic steps that are necessary for gathering and evaluating data. An overview of some of these steps is presented in this section to assist you in understanding conceptually the information discussed in the IWAIR section (Section B). The components of a risk assessment that are discussed in this section are: identification of chemicals of concern, source characterization, exposure assessment, and risk characterization. Each of these steps is described below as it applies specifically to risk resulting from the inhalation of organic chemicals emitted from waste management units to the ambient air.

#### Identification of Chemicals of Concern

A preliminary step in any risk assessment is the identification of chemicals of concern. These are the chemicals present that are anticipated to have potential health effects as

**Figure 2. Conceptual Site Diagram**

a result of their concentrations or toxicity factors. An assessment is performed for a given source, to evaluate chemical concentrations and toxicity of different chemicals. Based on these factors along with potential mechanisms of transport and exposure pathways, the decision is made to include or exclude chemicals in the risk assessment.

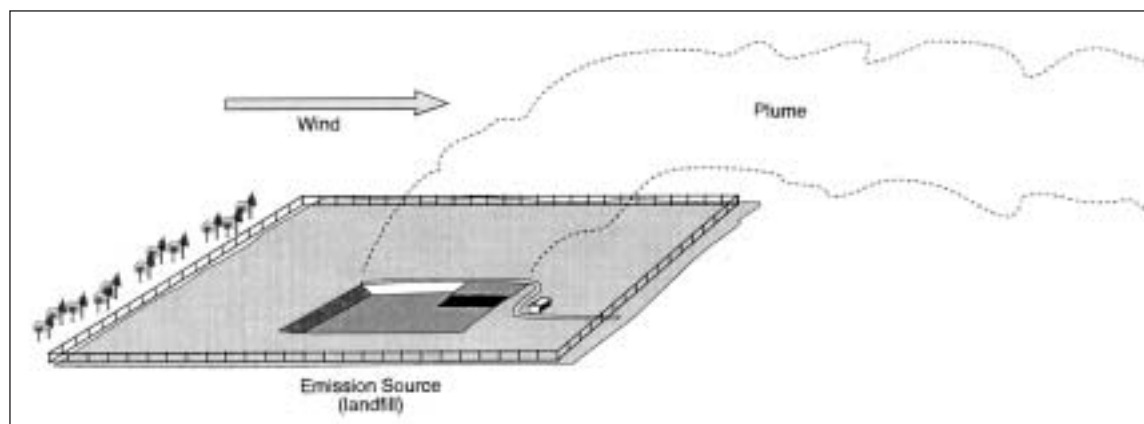
#### Source Characterization

In this step, the critical aspects of the source (e.g., type of WMU, size, chemical concentrations, location) are necessary to obtain. When modeling an area source, such as those included in the Guide, the amount of a given chemical that volatilizes and disperses from a source is critically dependent on the total surface area exposed. The source characterization should include information on the surface area and elevation of the unit. The volatilization is also dependent on other specific attributes related to the waste management practices. Waste management practices of importance include application frequency in land application units and the degree of aeration that occurs in a surface impoundment. Knowledge of the overall content of the waste being deposited in the

WMU is also needed to estimate chemical volatilization. Depending on its chemical characteristics, a chemical can bind with the other constituents in a waste, decreasing its emissions to the ambient air. Source characterization involves defining each of these key parameters for the WMU being modeled. The accuracy of projections concerning volatilization of chemicals from WMUs into ambient air is improved if more site-specific information is used in characterizing the source.

#### Exposure Assessment

The goal of an exposure assessment is to estimate the amount of a chemical that is available and is taken in by an individual, typically referred to as a receptor. An exposure assessment is performed in two steps: 1) the first step uses fate and transport modeling to determine the chemical concentration in air at a specified receptor location and, 2) the second step estimates the amount of the chemical the receptor will intake by identifying life-style activity patterns. The first step, the fate and transport modeling, uses a combination of an emission and dispersion model to estimate the amount of chemical that individuals residing or working within the vicini-

**Figure 3. Emissions from a WMU**

ty of the source are exposed to through inhalation of ambient air. When a chemical volatilizes from a WMU into the ambient air, it is subjected to a number of forces that result in its diffusion and transport away from the point of release.

In modeling the movement of the volatile chemical away from the WMU, it is often assumed that the chemical behaves as a plume (i.e., the chemical is continuously emitted into the environment) whose movement is modeled to produce estimated air concentrations at points of interest. This process is illustrated in Figure 3.

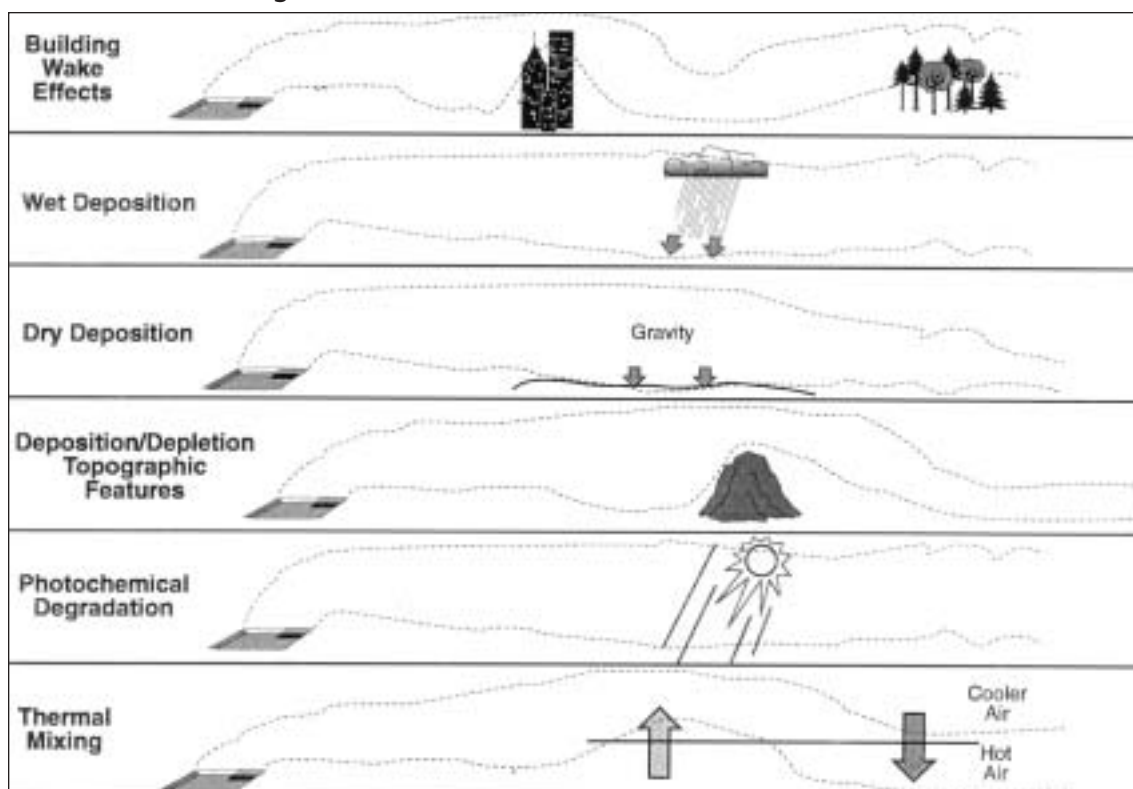
The pattern of diffusion and movement of chemicals that volatilize from WMUs depends on a number of interrelated factors. The ultimate concentration and fate of emissions to the air are most significantly impacted by three meteorologic conditions: atmospheric stability, wind speed, and wind direction. These meteorologic factors interact to determine the ultimate concentration of a pollutant in a localized area.

- **Atmospheric stability:** The stability of the atmosphere is influenced by the vertical temperature structure of the air above the emission source. In a stable environment, there is little or no movement of air parcels, and,

consequently, little or no movement and mixing of contaminants. In such a stable air environment, chemicals become “trapped” and unable to move. Conversely, in an unstable environment there is significant mixing and therefore greater dispersion and dilution of the plume.<sup>15</sup>

- **Prevailing wind patterns and their interaction with land features:** The nature of the wind patterns immediately surrounding the WMU can significantly impact the local air concentrations of airborne chemicals. Prevailing wind patterns combine with topographic features such as hills and buildings to affect the movement of the plume. Upon release, the initial direction that emissions will travel is the direction of the wind. The strength of the wind will determine how dilute the concentration of the pollutant will be in that direction. For example, if a strong wind is present at the time the pollutants are released, it is likely the pollutants will rapidly leave the source and become dispersed quickly into a large volume of air.

<sup>15</sup> An example of an unstable air environment is one in which the sun shining on the earth's surface has resulted in warmer air at the earth's surface. This warmer air will tend to rise, displacing any cooler air that is on top of it. As these air parcels essentially switch places, significant mixing occurs.

**Figure 4. Forces That Affect Contaminant Plumes.**

In addition to these factors affecting the diffusion and transport of a plume away from its point of release, the concentration of specific chemicals in a plume can also be affected by depletion. As volatile chemicals are transported away from the WMU, they can be removed from the ambient air through a number of depletion mechanisms including wet deposition (the removal of chemicals due to precipitation) and dry deposition (the removal of chemicals due to the forces of gravity and impacts of the plume on features such as vegetation). Chemicals can also be transformed chemically as they come in contact with the sun's rays (i.e., photochemical degradation). Figure 4 illustrates the forces acting to transport and deplete the contaminant plume.

Because the chemicals being considered in IWAIR are volatiles and semi-volatiles and the

distances of transport being considered are relatively short, the removal mechanisms shown in the figure are likely to have a relatively minor effect on plume concentration (both wet and dry deposition have significantly greater effects on airborne particulates).

Once the constituent's ambient outdoor concentration is determined, the receptor's extent of contact with the pollutant must be characterized. This step involves determining the location and activity patterns relevant to the receptor being considered. In IWAIR, the receptors are defined as residents and workers located at fixed distances from the WMU, and the only route of exposure considered for these receptors is the inhalation of volatiles. Typical activity patterns and body physiology of workers and residents are used to determine the intake of the constituent. Intake estimates quantify the extent to which

the individual is exposed to the contaminant and are a function of the breathing rate, exposure concentration, exposure duration, exposure frequency, exposure averaging time (for carcinogens), and body weight. Estimated exposures are presented in terms of the mass of the chemical per kilogram of receptor body weight per day.

#### Risk Characterization

The concentrations that an individual takes into his or her body that were determined during the exposure assessment phase are combined with toxicity values to generate risk estimates. Toxicity values used in IWAIR include inhalation-specific cancer slope factors (CSFs) for carcinogenic effects and reference concentrations (RfCs) for noncancer effects. These are explained in the General Risk Section in Chapter 1—Understanding Risk and Building Partnerships. Using these toxicity values, risk estimates are generated for carcinogenic effects and noncancer effects. Risk estimates for carcinogens are summed by IWAIR.

## B. IWAIR Model

IWAIR is an interactive computer program with three main components: an emissions model; a dispersion model to estimate fate and transport of constituents through the atmosphere and determine ambient air concentrations at specified receptor locations; and a risk model to calculate either the risk to exposed individuals or the waste constituent concentrations that can be protectively managed in the unit. To operate, the program requires only a limited amount of site-specific information, including facility location, WMU characteristics, waste characteristics, and receptor information. A brief description of each component follows. The *IWAIR Technical Background Document* (U.S. EPA, 2002a) contains a more detailed explanation of each.

### 1. Emissions Model

The emissions model uses waste characterization, WMU, and facility information to estimate emissions for 95 constituents that are identified in Table 5. The emission model selected for incorporation into IWAIR is EPA's CHEMDAT8 model. The entire CHEMDAT8 model is run as the emission component of the IWAIR model. CHEMDAT8 has undergone extensive review by both EPA and industry representatives and is publicly available from EPA's Web page, <[www.epa.gov/ttnchie1/software/water/water8.html](http://www.epa.gov/ttnchie1/software/water/water8.html)>.

To facilitate emission modeling with CHEMDAT8, IWAIR prompts the user to provide the required waste- and unit-specific data. Once these data are entered, the model calculates and displays chemical-specific emission rates. If users decide not to develop or use the CHEMDAT8 rates, they can enter their own site-specific emission rates ( $\text{g}/\text{m}^2\text{-s}$ ).

### 2. Dispersion Model

IWAIR's second modeling component estimates dispersion of volatilized contaminants and determines air concentrations at specified receptor locations, using default dispersion factors developed with EPA's Industrial Source Complex, Short-Term Model, version 3 (ISCST3). ISCST3 was run to calculate dispersion for a standardized unit emission rate ( $1 \mu\text{g}/\text{m}^2\text{-s}$ ) to obtain a unitized air concentration (UAC), also called a dispersion factor, which is measured in  $\mu/\text{m}^3$  per  $\mu\text{g}/\text{m}^2\text{-s}$ . The total air concentration estimates are then developed by multiplying the constituent-specific emission rates derived from CHEMDAT8 (or from another source) with a site-specific dispersion factor. Running ISCST3 to develop a new dispersion factor for each location/WMU is very time consuming and requires extensive meteorological data and technical expertise. Therefore IWAIR incorporates default dispersion factors

Table 5. Constituents Included in IWAIR

Chemical Abstracts (CAS) Number	Compound Name	Chemical Abstracts (CAS) Number	Compound Name
75-07-0	Acetaldehyde	77-47-4	Hexachlorocyclopentadine
67-64-1	Acetone	67-72-1	Hexachloroethane
75-05-8	Acetonitrile	78-59-1	Isophorone
107-02-8	Acrolein	7439-97-6	Mercury
79-06-1	Acrylamide	67-56-1	Methanol
79-10-7	Acrylic acid	110-49-6	Methoxyethanol acetate, 2-
107-13-1	Acrylonitrile	109-86-4	Methoxyethanol, 2-
107-05-1	Allyl chloride	74-83-9	Methyl bromide
62-53-3	Aniline	74-87-3	Methyl chloride
71-43-2	Benzene	78-93-3	Methyl ethyl ketone
92-87-5	Benzidine	108-10-1	Methyl isobutyl ketone
50-32-8	Benzo(a)pyrene	80-62-6	Methyl methacrylate
75-27-4	Bromodichloromethane	1634-04-4	Methyl tert-butyl ether
106-99-0	Butadiene, 1,3-	56-49-5	Methylcholanthrene, 3-
75-15-0	Carbon disulfide	75-09-2	Methylene chloride
56-23-5	Carbon tetrachloride	68-12-2	N-N-Dimethyl formamide
108-90-7	Chlorobenzene	91-20-3	Naphthalene
124-48-1	Chlorodibromomethane	110-54-3	n-Hexane
67-66-3	Chloroform	98-95-3	Nitrobenzene
95-57-8	Chlorophenol, 2-	79-46-9	Nitropropane, 2-
126-99-8	Chloroprene	55-18-5	NiNitrosodiethylamine
1006-10-15	cis-1,3-Dichloropropylene	924-16-3	N-Nitrosodi-n-butylamine
1319-77-3	Cresols (total)	930-55-2	N-Nitrosoyrrolidine
98-82-8	Cumene	95-50-1	o-Dichlorobenzene
108-93-0	Cyclohexanol	95-53-4	o-Toluidine
96-12-8	Dibromo-3-chloropropane, 1,2-	106-46-7	p-Dichlorobenzene
75-71-8	Dichlorodifluoromethane	108-95-2	Phenol
107-06-2	Dichloroethane, 1,2-	85-44-9	Phthalic anhydride
75-35-4	Dichloroethylene, 1,1-	75-56-9	Propylene oxide
78-87-5	Dichloropropane, 1,2-	110-86-1	Pyridine
57-97-6	Dimethylbenz[a]anthracene, 7,12-	100-42-5	Stryene
95-65-8	Dimethylphenol, 3,4-	1746-01-6	TCDD-2,3,7,8-
121-14-2	Dinitrotoluene, 2,4-	630-20-6	Tetrachloroethane, 1,1,1,2-
123-91-1	Dioxane, 1,4-	79-34-5	Tetrachloroethane, 1,1,2,2-
122-66-7	Diphenylhydrazine, 1,2-	127-18-4	Tetrachloroethylene
106-89-8	Epichlorohydrin	108-88-3	Toluene
106-88-7	Epoxybutane, 1,2-	10061-02-6	trans-1,3-Dichloropropylene
11-11-59	Ethoxyethanol acetate, 2-	75-25-2	Tribromomethane
110-80-5	Ethoxyethanol, 2-	76-13-1	Freon 113 (Trichloro-1,2,2- 1,1,2- trifluoroethane)
100-41-4	Ethylbenzene	120-82-1	Trichlorobenzene, 1,2,4-
106-93-4	Ethylene dibromide	71-55-6	Trichloroethane, 1,1,1-
107-21-1	Ethylene glycol	79-00-5	Trichloroethane, 1,1,2-
75-21-8	Ethylene oxide	79-01-6	Trichloroethylene
50-00-0	Formaldehyde	75-69-4	Trichlorofluoromethane
98-01-1	Furfural	121-44-8	Triethylamine
87-68-3	Hexachloro-1,3-butadiene	108-05-4	Vinyl acetate
118-74-1	Hexchlorobenzene	75-01-4	Vinyl chloride
		1330-20-7	Xylenes

developed by ISCST3 for many separate scenarios designed to cover a broad range of unit characteristics, including:

- 60 meteorological stations, chosen to represent the 9 general climate regions of the continental U.S.
- 4 unit types.
- 17 surface area sizes for landfills, land application units and surface impoundments, and 11 surface area sizes and 7 heights for waste piles.
- 6 receptor distances from the unit (25, 50, 75, 150, 500, 1000 meters).
- 16 directions in relation to the edge of the unit.

The default dispersion factors were derived by modeling many scenarios with various combinations of parameters, then choosing as the default the maximum dispersion factor for each waste management unit/surface area/meteorological station/receptor distance combination.

Based on the size and location of a unit, as specified by a user, IWAIR selects an appropriate dispersion factor from the default dispersion factors in the model. If the user specifies a unit surface area that falls between two of the sizes already modeled, a linear interpolation method will estimate dispersion in relation to the two closest unit sizes.

Alternatively, a user can enter a site-specific dispersion factor developed by conducting independent modeling with ISCST3 or with a different model and proceed to the next step, the risk calculation.

### 3. Risk Model

The third component to the model combines the constituent's air concentration with receptor exposure factors and toxicity benchmarks to calculate either the risk from con-

centrations managed in the unit or the waste concentration ( $C_w$ ) in the unit that should not be exceeded to protect human health. In calculating either estimate, the model applies default values for exposure factors, including inhalation rate, body weight, exposure duration, and exposure frequency. These default values are based on data presented in the *Exposure Factors Handbook* (U.S. EPA, 1995a) and represent average exposure conditions. IWAIR maintains standard health benchmarks (CSFs for carcinogens and RfCs for noncarcinogens) for 95 constituents. These health benchmarks are from the Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST). IWAIR uses these data to perform either a forward calculation to obtain risk estimates or a backward calculation to obtain protective waste concentration estimates.

### 4. Estimation Process

Figure 5 provides an overview of the step-wise approach the user follows to calculate risk or protective waste concentration estimates with IWAIR. The seven steps of the estimation process are shown down the right side of the figure, and the user specified inputs are listed to the left of each step. As the user provides input data, the program proceeds to the next step. Each step of the estimation process is discussed below.

- Select Calculation Method.** The user selects one of two calculation methods. Use the forward calculation to arrive at chemical-specific and cumulative risk estimates if the user knows the concentrations of constituents in the waste. Use the backward calculation method to estimate protective waste concentrations not to be exceeded in new units. The screen where this step is performed is shown in Figure 6.

**Figure 5. IWAIR Approach for Developing Risk or Protective Waste Concentrations:**  
This figure shows the steps in the tool to assist the user in developing risk or protective waste concentration estimates.

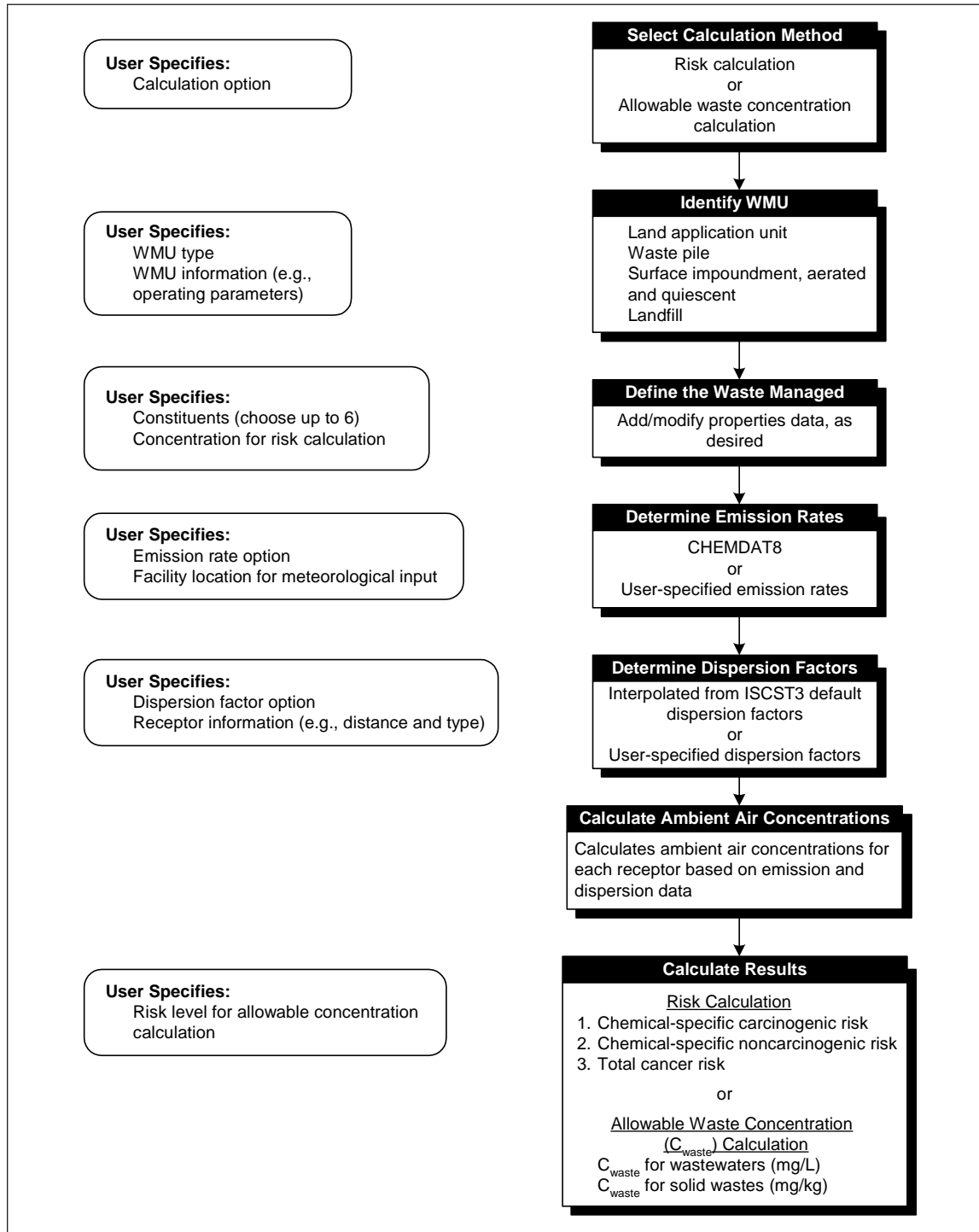


Figure 6. Screen 1, Method, Met Station, WMU.

**Industrial Waste - [1a. Waste Management Unit Type]**

File Help

Emission Rates Dispersion Factors Results

Method, Met. Station, WMU Wastes Managed WMU Data for CHENDATS

**1. Select Calculation Method**

☒ Calculate risk Calculation to estimate risk for specified chemical concentrations

☐ Calculate allowable concentration Calculation to estimate chemical concentrations based on specified risk

**2. Select Waste Management Unit (WMU) Type**

☒ Surface impoundment

☐ Land application unit

☐ Active landfill

☐ Waste pile

**3. Selection of Best Meteorological Station for Site**

☒ Search by zip code

☐ Search by latitude and longitude coordinates

**Enter 5-digit Zip Code of Site**

Search

**Enter Latitude and Longitude of Site**

Latitude deg min sec

Longitude deg min sec

Search

**Selected Meteorological Station for Site**

View Map

**4. Select Emissions and Dispersion Option**

☒ Use CHENDATS Use CHENDATS to estimate emission rates and use dispersion factors provided

OR

☐ Enter Emission Rates Directly enter emission rates without using CHENDATS and use dispersion factors provided

OR

☐ Enter Emission & Dispersion Data Directly enter emission rates and dispersion factors

Figure 7. Screen 2, Wastes Managed.

**Industrial Waste - [2a. Wastes Managed in WMUs]**

File Help

Emission Rates Dispersion Factors Results

Method, Met. Station, WMU Wastes Managed WMU Data for CHENDATS

**Identify Chemicals of Concern**

To select chemical in management unit, click on chemical in list and click "Add >>". or double-click on chemical in list

To remove chemical in management unit, select chemical to remove and click "<< Remove"

To add a chemical to the list or to modify properties for a user-defined chemical, click "Add/Modify Chemicals"

☒ Sort by chemical name

☐ Sort by CAS number

Add/Modify Chemicals

Add >>

<< Remove

Done

**Chemicals in waste**

Chemical	Concentration (ng/L or mg/kg)	Select chemical to remove
1,1,1,2-Tetrachloroethane	100	<input type="checkbox"/>
Acetone	200	<input type="checkbox"/>
Carbon disulfide	300	<input type="checkbox"/>
		<input type="checkbox"/>
		<input type="checkbox"/>
		<input type="checkbox"/>

- b. **Identify Waste Management Unit.** Four WMU types can be modeled: surface impoundments (SIs), land application units (LAUs), active landfills (LFs), and wastepiles (WPs). For each WMU, you will be asked to specify some design and operating parameters such as surface area, depth for surface impoundments and landfills, height for wastepiles, and tilling depth for LAUs. The amount of unit specific data needed as input will vary depending on whether the user elects to develop CHEMDAT8 emission rates. IWAIR provides default values for several of the operating parameters that the user can choose, if appropriate.
- c. **Define Waste Managed.** Specify constituents and concentrations in the waste if you choose a forward calculation to arrive at chemical specific risk estimates. If you choose a backward calculation to estimate protective waste concentrations, then specify constituents of concern. The screen where this step is performed is shown in Figure 7.
- d. **Determine Emission Rates.** You can elect to develop CHEMDAT8 emission rates or provide your own site-specific emission rates for use in calculations. IWAIR will also ask for facility location information to link the facility's location to one of the 60 IWAIR meteorological stations. Data from the meteorological stations provide wind speed and temperature information needed to develop emission estimates. In some circumstances the user might already have emissions information from monitoring or a previous modeling exercise. As an alternative to using the CHEMDAT8 rates, a user can provide their own site-specific emission rates developed with a different model or based on emission measurements.
- e. **Determine Dispersion.** The user can provide site-specific unitized dispersion factors ( $\mu\text{g}/\text{m}^3$  per  $\mu\text{g}/\text{m}^2\text{-s}$ ) or have the model develop dispersion factors based on user-specified WMU information and the IWAIR default dispersion data. Because a number of assumptions were made in developing the IWAIR default dispersion data you can elect to provide site-specific dispersion factors which can be developed by conducting independent modeling with ISCST3 or with a different model. Whether you use IWAIR or provide dispersion factors from another source, specify distance to the receptor from the edge of the WMU and the receptor type (i.e., resident or worker). These data are used to define points of exposure.
- f. **Calculate Ambient Air Concentration.** For each receptor, the model combines emission rates and dispersion data to estimate ambient air concentrations for all waste constituents of concern.
- g. **Calculate Results.** The model calculates results by combining estimated ambient air concentrations at a specified exposure point with receptor exposure factors and toxicity benchmarks. Presentation of results depends on whether you chose a forward or backward calculation:  
  
*Forward calculation:* Results are estimates of cancer and non-cancer risks from inhalation exposure to volatilized constituents in the waste. If risks are too high, options are: 1) implement unit controls to reduce volatile air emissions, 2) implement pollution preven-

tion or treatment to reduce volatile organic compound (VOC) concentrations before the waste enters the unit, or 3) conduct a full site-specific risk assessment to more precisely characterize risks from the unit.

*Backward calculation:* Results are estimates of constituent concentrations in waste that can be protectively managed in the unit so as not to exceed a defined risk level (e.g.,  $1 \times 10^{-6}$  or hazard quotient of 1) for specified receptors. A target risk level for your site can be calculated based on a number of site-specific factors including, proximity to potential receptors, waste characteristics, and waste management practices. This information should be used to determine preferred characteristics for wastes entering the unit. There are several options if it appears that planned waste concentrations might be too high: 1) implement pollution prevention or treatment to reduce VOC concentrations in the waste, 2) modify waste management practices to better control VOCs (for example, use closed tanks rather than surface impoundments), or 3) conduct a full site-specific risk assessment to more precisely characterize risks from the unit.

## 5. *Capabilities and Limitations of the Model*

In many cases, IWAIR will provide a reasonable alternative to conducting a full-scale site-specific risk analysis to determine if a WMU poses unacceptable risk to human health. Because the model can accommodate only a limited amount of site-specific information, however, it is important to understand its capabilities and recognize situations when it might not be appropriate to use.

### Capabilities

- The model provides a reasonable representation of VOC inhalation risks

associated with waste management units.

- The model is easy-to-use and requires a minimal amount of data and expertise.
- The model is flexible and provides features to meet a variety of user needs.
- A user can enter emission and/or dispersion factors derived from another model (perhaps to avoid some of the limitations below) and still use IWAIR to conduct a risk evaluation.
- The model can run a forward calculation from the unit or a backward calculation from the receptor point.
- A user can modify health benchmarks (HBNs) and target risk level, when appropriate and in consultation with other stakeholders.

### Limitations

- **Release Mechanisms and Exposure Routes.** The model considers exposures from breathing ambient air. It does not address potential risks attributable to particulate releases nor does it address risks associated with indirect routes of exposure (i.e., non-inhalation routes of exposure). Additionally, in the absence of user-specified emission rates, volatile emission estimates are developed with CHEMDAT8 based on unit- and waste-specific data. The CHEMDAT8 model was developed to address only volatile emissions from waste management units. Competing mechanisms that can generate additional exposures to the constituents in the waste such as runoff, erosion, and

particulate emissions are not accounted for in the model.

- **Waste Management Practices.** The user specifies a number of unit-specific parameters that significantly impact the inhalation pathway (e.g., size, type, and location of WMU, which is important in identifying meteorological conditions). However, the model cannot accommodate information concerning control technologies such as covers that might influence the degree of volatilization (e.g., whether a wastepile is covered immediately after application of new waste). In this case, it might be advisable to generate site-specific emission rates and enter those into IWAIR.
- **Terrain and Meteorological Conditions.** If a facility is located in an area of intermediate or complex terrain or with unusual meteorological conditions, it might be advisable to either 1) generate site-specific air dispersion modeling results for the site and enter those results into the program, or 2) use a site-specific risk modeling approach different from IWAIR. The model will inform the user which of the 60 meteorological stations is used for a facility. If the local meteorological conditions are very different from the site chosen by the model, it would be more accurate to choose a different model.

The terrain type surrounding a facility can impact air dispersion modeling results and ultimately risk estimates. In performing air dispersion modeling to develop the IWAIR default dispersion factors, the model ISCST3 assumes the area around the WMU is of simple or flat terrain. The *Guideline on Air Quality Models* (U.S.

EPA, 1993) can assist users in determining whether a facility is in an area of simple, intermediate, or complex terrain.

- **Receptor Type and Location.** IWAIR has predetermined adult worker and resident receptors, six receptor locations, and predetermined exposure factors. The program cannot be used to characterize risk for other possible exposure scenarios. For example, the model can not evaluate receptors that are closer to the unit than 25 meters or those that are further from the unit than 1,000 meters. If the population of concern for your facility is located beyond the limits used in IWAIR, consider using a model that is more appropriate for the risks posed from your facility.

## C. Site-specific Risk Analysis

IWAIR is not the only model that can be applicable to a site. In some cases, a site-specific risk assessment might be more advantageous. A site-specific approach can be tailored to accommodate the individual needs of a particular WMU. Such an approach would rely on site-specific data and on the application of existing fate and transport models. Table 6 summarizes available emissions and/or dispersion models that can be applied in a site-specific analysis. Practical considerations include the source of the model(s), the ease in obtaining the model(s), and the nature of the model(s) (i.e., is it proprietary), and the availability of site-specific data required for use of the model. Finally, the model selection process should determine whether or not the model has been verified against analytical solutions, other models, and/or field data. Proper models can be selected based on the physical and chemical

Table 6  
Source Characterization Models

Model Name	Summary
AP-42	<p>The EPA's Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources (AP-42), is a compilation of emission factors for a wide variety of air emission sources, including fugitive dust sources (Section 13.2). Emission factors are included for paved roads, unpaved roads, heavy construction operations, aggregate handling and storage piles, industrial wind erosion (this is the 1988 Cowherd model), and abrasive blasting. These are simple emission factors or equations that relate emissions to inputs (e.g., silt loading or content, moisture content, mean vehicle weight, area, activity level, and wind speed). Guidance is provided for most inputs, but the more site-specific the input data used, the more accurate the results.</p> <p>The entire AP-42 documentation is available at &lt;<a href="http://www.epa.gov/ttn/chief/efinformation.html">www.epa.gov/ttn/chief/efinformation.html</a>&gt;.</p>
CHEMDAT8	<p>The CHEMDAT8 model allows the user to conduct source and chemical specific emissions modeling. CHEMDAT8 is a Lotus 1-2-3 spreadsheet that includes analytical models to estimate volatile organic compound emissions from treatment, storage, and disposal facility processes under user-specified input parameters. CHEMDAT8 calculates the fractions of waste constituents of interest that are distributed among pathways (partition fractions) applicable to the facility under analysis.</p> <p>Emissions modeling using CHEMDAT8 is conducted using data entered by the user for unit-specific parameters. The user can choose to override the default data and enter their estimates for these unit-specific parameters. Thus, modeling emissions using CHEMDAT8 can be done with a limited amount of site-specific information.</p> <p>Available at &lt;<a href="http://www.epa.gov/ttnchie1/software/water/water8.html">www.epa.gov/ttnchie1/software/water/water8.html</a>&gt;, hotline at 919 541-5610 for more information.</p>
Cowherd	<p>The Cowherd model, Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites, allows the user to calculate particulate emission rates for wind erosion using data on wind speed and various parameters that describe the surface being eroded. The latest (1988) version of this model is event-based (i.e., erosion is modeled as occurring in response to specific events in which the wind speed exceeds levels needed to cause wind erosion). An older (1985) version of the model is not event-based (i.e., erosion is modeled as a long-term average, without regard to specific wind speed patterns over time). The older version is less complicated and requires fewer inputs, but produces more conservative results (i.e., higher emissions). The documentation on both models provides guidance on developing all inputs. Both require data on wind speed (fastest mile for the 1988 version and annual average for the 1985 version), anemometer height, roughness height, and threshold friction velocity. The 1985 version also requires input on vegetative cover. The 1988 version requires data on number of disturbances per year and, if the source is not a flat surface, pile shape and orientation to the fastest mile.</p> <p>The 1985 version of the model is presented in Rapid Assessment of Exposures to Particulate Emissions from Surface Contamination Sites (U.S. EPA, 1985). Office of Health and Environmental Assessment, Washington DC.</p> <p>The 1988 version of the model is available as part of AP-42, Section 13.2.5 (see above).</p>

Table 6  
Source Characterization Models

Model Name	Summary
ISCLT3	<p>The Industrial Source Complex Model-Long Term, ISCLT3, is a steady state Gaussian plume dispersion model that can be used to model dispersion of continuous emissions from point or area sources over transport distances of less than 50km. It can estimate air concentration for vapors and particles, and dry deposition rates for particles (but not vapors), and can produce these outputs averaged over seasonal, annual, or longer time frames. ISCLT3 inputs include readily available meteorological data known as STAR (STability ARray) summaries (these are joint frequency distributions of wind speed class by wind direction sector and stability class, and are available from the National Climate Data Center in Asheville, North Carolina), and information on source characteristics (such as height, area, emission rate), receptor locations, and a variety of modeling options (such as rural or urban). Limitations of ISCLT3 include inability to model wet deposition, deposition of vapors, complex terrain, or shorter averaging times than seasonal, all of which can be modeled by ISCST3. In addition, the area source algorithm used in ISCLT3 is less accurate than the one used in ISCST3. The runtime for area sources, however, is significantly shorter for ISCLT3 than for ISCST3.</p> <p>ISCLT3 is available at &lt;<a href="http://www.epa.gov/scram001/tt22.htm">www.epa.gov/scram001/tt22.htm</a>&gt;.</p>
ISCST3	<p>A steady-state Gaussian plume dispersion model that can estimate concentration, dry deposition rates (particles only), and wet deposition rates. Is applicable for continuous emissions, industrial source complexes, rural or urban areas, simple or complex terrain, transport distances of less than 50 km, and averaging times from hourly to annual.</p> <p>Available at &lt;<a href="http://www.epa.gov/scram001/tt22.htm">www.epa.gov/scram001/tt22.htm</a>&gt;.</p>
Landfill Air Emissions Estimation Model (LAEEM)	<p>Used to estimate emission rates for methane, carbon dioxide, nonmethane volatile organic compounds, and other hazardous air pollutants from municipal solid waste landfills. The mathematical model is based on a first order decay equation that can be run using site-specific data supplied by the user for the parameters needed to estimate emissions or, if data are not available, using default value sets included in the model.</p> <p>Developed by the Clean Air Technology Center (CATC). Can be used to estimate emission rates for methane, carbon dioxide, nonmethane organic compounds, and individual air pollutants from landfills. Can also be used by landfill owners and operators to determine if a landfill is subject to the control requirements of the federal New Source Performance Standard (NSPS) for new municipal solid waste (MSW) landfills (40 CFR 60 Subpart WWW) or the emission guidelines for existing MSW landfills (40 CFR 60 Subpart CC).</p> <p>Developed for municipal solid waste landfills; might not be appropriate for all industrial waste management units.</p> <p>Available at &lt;<a href="http://www.epa.gov/ttn/chief/software/index.html">www.epa.gov/ttn/chief/software/index.html</a>&gt;.</p>

Table 6  
Source Characterization Models

Model Name	Summary
Wastewater Treatment Compound Property Processor and Air Emissions Estimator Program (WATER9)	<p>WATER9 is a Windows based computer program and consists of analytical expressions for estimating air emissions of individual waste constituents in wastewater collection, storage, treatment, and disposal facilities; a database listing many of the organic compounds; and procedures for obtaining reports of constituent fates, including air emissions and treatment effectiveness.</p> <p>WATER9 is a significant upgrade of features previously obtained in the computer programs WATER8, Chem9, and Chemdat8. WATER9 contains a set of model units that can be used together in a project to provide a model for an entire facility. WATER9 is able to evaluate a full facility that contains multiple wastewater inlet streams, multiple collection systems, and complex treatment configurations. It also provides separate emission estimates for each individual compound that is identified as a constituent of the wastes.</p> <p>WATER9 has the ability to use site-specific compound property information, and the ability to estimate missing compound property values. Estimates of the total air emissions from the wastes are obtained by summing the estimates for the individual compounds. The EPA document <i>Air Emissions Models for Waste and Wastewater</i> (U.S. EPA, 1994a) includes the equations used in the WATER9 model.</p> <p>Available at &lt;<a href="http://www.epa.gov/ttnchie1/software/water/water9/index.html">www.epa.gov/ttnchie1/software/water/water9/index.html</a>&gt;. Contact the Air Emissions Model Hotline at 919 541-5610 for support or more information.</p>
Toxic Modeling System Short Term (TOXST)	<p>An interactive PC-based system to analyze intermittent emissions from toxic sources. Estimates the dispersion of toxic air pollutants from point, area, and volume sources at a complex industrial site. This system uses a Monte Carlo simulation to allow the estimation of ambient concentration impacts for single and multiple pollutants from continuous and intermittent sources. In addition, the model estimates the average annual frequency with which user-specified concentration thresholds are expected to be exceeded at receptor sites around the modeled facility. TOXST requires the use of ISCT3 model input files for physical source parameters.</p> <p>Available at &lt;<a href="http://www.epa.gov/rgytgrnj/programs/artd/toxics/arpp/etools.htm">www.epa.gov/rgytgrnj/programs/artd/toxics/arpp/etools.htm</a>&gt;.</p>
Toxic Screening Model (TSCREEN)	<p>TSCREEN, a Model for Screening Toxic Air Pollutant Concentrations, should be used in conjunction with the "Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants." The air toxics dispersion screening models imbedded in TSCREEN that are used for the various scenarios are SCREEN2, RVD, PUFF, and the Britter-McQuaid model. Using TSCREEN, a particular release scenario is selected via input parameters, and TSCREEN model to simulate that scenario. The model to be used and the worst case meteorological conditions are automatically selected based on criteria given in the workbook. TSCREEN has a front-end control program to the models that also provides, by use of interactive menus and data entry screen, the same steps as the workbook.</p>

attributes of the site in question. As with all modeling, however, you should consult with your state prior to investing significant resources in a site-specific analysis. The state might have preferred models or might be able to help plan the analysis.

### III. Emission Control Techniques

#### A. Controlling Particulate Matter

Particulate matter (PM) consists of airborne solid and liquid particles. PM is easily inhaled and can cause various health problems. PM also impacts the environment by decreasing visibility and harming plants as well as transporting constituents off site. Constituents can sorb to particulate matter and, therefore, wind blown dust is a potential pathway for constituents to leave the site. It is recommended that facilities adopt controls to address emissions of airborne particulates.

Solid PM that becomes airborne directly or indirectly as a result of human activity, is referred to as fugitive dust<sup>16</sup> and it can be generated from a number of different sources. The most common sources of fugitive dust at waste management units include vehicular traffic on unpaved roads and land-based units, wind erosion from land-based units, and waste handling procedures. Developing a fugitive dust control plan is an efficient way to tackle these problems. The plan should include a description of all operations conducted at the unit, a map, a list of all fugitive dust sources at the unit, and a description of the control measures that will be used to minimize fugitive dust emissions. OSHA has established standards for occupational exposure to dust (see 29 CFR § 1910.1000). You

should check to see if your state also has regulations or guidance concerning dust or fugitive emission control.

PM emissions at waste management units vary with the physical and chemical characteristics of waste streams; the volume of waste handled; the size of the unit, its location, and associated climate; and waste transportation and placement practices. The subsections below discuss the main PM-generating operations and identify emission control techniques. The waste management units of main concern for PM emissions include landfills, waste piles, land application units, and closed surface impoundments.

##### 1. Vehicular Operations

Waste and cover material are often transported to units using trucks. If the waste has the potential for PM to escape to the atmosphere during transport, you should cover the waste with tarps or place wastes in containers such as double bags or drums.<sup>17</sup>

A unit can also use vehicles to construct lifts in landfills, apply liquids to land application units, or dredge surface impoundments. Consider using “dedicated” equipment—vehicles that operate only within the unit and are not routinely removed from the unit to perform other activities. This practice reduces the likelihood that equipment movement will spread contaminated PM outside the unit. To control PM emissions when equipment must be removed from the landfill unit, such as for maintenance, a wash station can remove any contaminated material from the equipment before it leaves the unit. You should ensure that this is done in a curbed wash area where wash water is captured and properly handled.

To minimize PM emissions from all vehicles, it is recommended that you construct temporary roadways with gravel or other

<sup>16</sup> Fugitive emissions are defined as emissions not caught by a capture system and therefore exclude PM emitted from exhaust stacks with control devices.

<sup>17</sup> Containerizing wastes provides highly effective control of PM emissions, but, due to the large volume of many industrial waste streams, containerizing waste might not always be feasible.

coarse aggregate material to reduce silt content and thus, dust generation. In addition, consider regularly cleaning paved roads and other travel surfaces of dust, mud, and contaminated material.

In land application units, the entire application surface is often covered with a soil-waste mix. The most critical preventive control measure, therefore, involves minimizing contact between the application surface and waste delivery vehicles. If possible, allow only dedicated application vehicles on the surface, restricting delivery vehicles to a staging or loading area where they deposit waste into application vehicles or holding tanks. If delivery vehicles must enter the application area, ensure that mud and waste are not tracked out and deposited on roadways, where they can dry and then be dispersed by wind or passing vehicles.

## 2. *Waste Placement and Handling*

PM emissions from waste placement and handling activities are less likely if exposed material has a high moisture content. Therefore, consider wetting the waste prior to loadout. Increasing the moisture content, however, might not be suitable for all waste streams and can result in an unacceptable increase in leachate production. To reduce the need for water or suppressants, cover or confine freshly exposed material. In addition, consider increasing the moisture content of the cover material.

It can also be useful to apply water to unit surfaces after waste placement. Water is generally applied using a truck with a gravity or pressure feed. Watering might or might not be advisable depending on application intensity and frequency, the potential for tracking of contaminated material off site, and climatic conditions. PM control efficiency generally



increases with application intensity and frequency but also depends on activity levels, climate, and initial surface conditions. Infrequent or low-intensity water application typically will not provide effective control, while too frequent or high-intensity application can increase leachate volume, which can strain leachate collection systems and threaten ground water and surface water. Addition of excess water to bulk waste material or to unit surfaces also can reduce the structural integrity of the landfill lifts, increase tracking of contaminated mud off site, and increase odor. These undesirable possibilities can have long-term implications for the proper management of a unit. Before instituting a watering program, therefore, ensure that addition of water does not produce undesirable impacts on ground- and surface-water quality. You should consult with your state agency with respect to these problems.

Chemical dust suppressants are an alternative to water application. The suppressants are detergent-like surfactants that increase the total number of droplets and allow particles to more easily penetrate the droplets, increasing the total surface area and contact potential. Adding a surfactant to a relatively small quantity of water and mixing vigorously produces small-bubble, high-energy foam in the 100 to 200  $\mu\text{m}$  size range. The foam occupies very little liquid volume, and when applied to the surface of the bulk material, wets the fines

Table 7. Example List of Chemical Suppressants\*

Type	Product	Manufacturer
Bitumens	AMS 2200, 2300®	Arco Mine Sciences
	Coherex®	Witco Chemical
	Docal 1002®	Douglas Oil Company
	Penepriime®	Utah Emulsions
	Petro Tac P®	Syntech Products Corporation
	Resinex®	Neyra Industries, Inc.
	Retain®	Dubois Chemical Company
Salts	Calcium chloride	Allied Chemical Corporation
	Dowflake, Liquid Dow®	Dow Chemical
	DP-10®	Wen-Don Corporation
	Dust Ban 8806®	Nalco Chemical Company
	Dustgard®	G.S.L. Minerals and Chemical Corporation
	Sodium silicate	The PQ Corporation
Adhesives	Acrylic DLR-MS®	Rohm and Haas Company
	Bio Cat 300-1®	Applied Natural Systems, Inc.
	CPB-12®	Wen-Don Corporation
	Curasol AK®	American Hoechst Corporation
	DCL-40A, 1801, 1803®	Calgon Corporation
	DC-859, 875®	Betz Laboratories, Inc.
	Dust Ban®	Nalco Chemical Company
	Flambinder®	Flambeau Paper Company
	Lignosite®	Georgia Pacific Corporation
	Norlig A, 12®	Reed Lignin, Inc.
	Orzan Series®	Crown Zellerbach Corporation
	Soil Gard®	Walsh Chemical

\* Mention of trade names or commercial products is not intended to constitute endorsement or recommendation for use.

Source: U.S. EPA, 1989.

more effectively than water. When applied to a unit, suppressants cement loose material into a more impervious surface or form a surface which attracts and retains moisture. Examples of chemical dust suppressants are provided in Table 7. The degree of control achieved is a function of the application intensity and frequency and the dilution ratio. Chemical dust suppressants tend to require less frequent application than water, reducing the potential for leachate generation. Their

efficiency varies, depending on the same factors as water application, as well as spray nozzle parameters, but generally falls between 60 and 90 percent reduction in fugitive dust emissions. Suppressant costs, however, can be high.

At land application units, if wastes contain considerable moisture, PM can be suppressed through application of more waste rather than water or chemical suppressants. This method, however, is only viable if it would

not cause an exceedence of a design waste application rate or exceed the capacity of soil and plants to assimilate waste.

At surface impoundments, the liquid nature of the waste means PM is not a major concern while the unit is operational. Inactive or closed surface impoundments, however, can emit PM during scraping or bulldozing operations to remove residual materials. The uppermost layer of the low permeability soils, such as compacted clay, which can be used to line a surface impoundment, contains the highest contaminant concentrations. Particulate emissions from this uppermost layer, therefore, are the chief contributor to contaminant emissions. When removing residuals from active units, you should ensure that equipment scrapes only the residuals, avoiding the liner below.

### 3. *Wind Erosion*

Wind erosion occurs when a dry surface is exposed to the atmosphere. The effect is most pronounced with bare surfaces of small particles, such as silty soil; heavier or better anchored material, such as stones or clumps of vegetation, has limited erosion potential and requires higher wind speeds before erosion can begin.

Compacted clay and in-situ soil liners tend to form crusts as their surfaces dry. Crusted surfaces usually have little or no erosion potential. Examine the crust thickness and strength during site inspections. If the crust does not crumble easily the erosion potential might be minimal.

Wind fences or barriers are effective means by which to control fugitive dust emissions from open dust sources. The wind fence or barrier reduces wind velocity and turbulence in an area whose length is many times the height of the fence. This allows settling of large particles and reduces emissions from

the exposed surface. It can also shelter materials handling operations to reduce entrainment during load-in and loadout. Wind fences or barriers can be portable and either man-made structures or vegetative barriers, such as trees. A number of studies have attempted to determine the effectiveness of wind fences or barriers for the control of windblown dust under field conditions. Several of these studies have shown a decrease in wind velocity, however, the degree of emissions reduction varies significantly from study to study depending on test conditions.

Other wind erosion control measures include passive enclosures such as three-sided bunkers for the storage of bulk materials, storage silos for various types of aggregate material, and open-ended buildings. Such enclosures are most easily used with small, temporary waste piles. At land application units that use spray application, further wind erosion control can be achieved simply by not spraying waste on windy days.

Windblown PM emissions from a waste pile depend on how frequently the pile is disturbed, the moisture content of the waste, the proportion of aggregate fines, and the height of the pile. When small-particle wastes are loaded onto a waste pile, the potential for dust emissions is at a maximum, as small particles are easily disaggregated and picked up by wind. This tends to occur when material is either added to or removed from the pile or when the pile is otherwise reshaped. On the other hand, when the waste remains undisturbed for long periods and is weathered, its potential for dust emissions can be greatly reduced. This occurs when moisture from precipitation and condensation causes aggregation and cementation of fine particles to the surface of larger particles, and when vegetation grows on the pile, shielding the surface and strengthening it with roots.

Finally, limiting the height of the pile can reduce PM emissions, as wind velocities generally increase with distance from the ground.

## **B. VOC Emission Control Techniques**

If air modeling indicates that VOC emissions are a concern, you should consider pollution prevention and treatment options to reduce risk. There are several control techniques you can use. Some are applied before the waste is placed in the unit, reducing emissions; others contain emissions that occur after waste placement; still others process the captured emissions.

### **1. *Choosing a Site to Minimize Airborne Emission Problems***

Careful site choice can reduce VOC emissions. Locations that are sheltered from wind by trees or other natural features are preferable. Knowing the direction of prevailing winds and determining whether the unit would be upwind from existing and expected future residences, businesses, or other population centers can result in better siting of units. After a unit is sited, observe wind direction during waste placement, and plan or move work areas accordingly to reduce airborne emission impacts on neighbors.

### **2. *Pretreatment of Waste***

Pretreating waste can remove organic compounds and possibly eliminate the need for further air emission controls. Organic removal or pretreatment is feasible for a variety of wastes. These processes, which include steam or air stripping, thin-film evaporation, solvent extraction, and distillation, can sometimes remove essentially all of the highly volatile compounds from your waste.

Removal of the volatiles near the point of generation can obviate the need for controls on your subsequent process units and can facilitate recycling the recovered organics back to the process.

The control efficiency of organic removal depends on many factors, such as emissions from the removal system, and the uncontrolled emissions from management units before the removal device was installed. Generally, overall organic removal efficiencies of 98 to over 99 percent can be achieved.

### **3. *Enclosure of Units***

You might be able to control VOC emissions from your landfill or waste pile by installing a flexible membrane cover, enclosing the unit in a rigid structure, or using an air-supported structure. Fans maintain positive pressure to inflate an air-supported structure. Some of the air-supported covers that have been used consist of PVC-coated polyester with a polyvinyl fluoride film backing. The efficiency of air-supported structures depends primarily on how well the structure prevents leaks and how quickly any leaks that do occur are detected. For effective control, the air vented from the structure should be sent to a control device, such as a carbon adsorber. Worker safety issues related to access to the interior of any flexible membrane cover or other pollutant concentration system should also be considered.

Wind fences or barriers can also aid in reducing organic emissions by reducing air mixing on the leeward side of the screen. In addition, wind fences reduce soil moisture loss due to wind, which can in turn result in decreased VOC emissions.

Floating membrane covers provide control on various types of surface impoundments, including water reservoirs in the western United States. For successful control of

organic compounds, the membrane must provide a seal at the edge of the impoundment and rainwater must be removed. If gas is generated under the cover, vents and a control device might also be needed. Emission control depends primarily on the type of membrane, its thickness, and the nature of the organic compounds in the waste. Again, we recommend that you consult with your state or local air quality agency to identify the most appropriate emission control for your impoundment.

#### 4. *Treatment of Captured VOCs*

In some cases, waste will still emit some VOCs despite waste reduction or pretreatment efforts. Enclosing the unit serves to prevent the immediate escape of these VOCs to the atmosphere. To avoid eventually releasing VOCs through an enclosure's ventilation system, a treatment system is necessary. Some of the better-known treatment methods are discussed below; others also are available.

##### a. *Adsorption*

Adsorption is the adherence of particles of one substance, in this case VOCs, to the surface of another substance, in this case a filtration or treatment matrix. The matrix can be replaced or flushed when its surface becomes saturated with the collected VOCs.

**Carbon Adsorption.** In carbon adsorption, organics are selectively collected on the surface of a porous solid. Activated carbon is a common adsorbent because of its high internal surface area: 1 gram of carbon can have a surface area equal to that of a football field and can typically adsorb up to half its weight in organics. For adsorption to be effective, replace, regenerate, or recharge the carbon when treatment efficiency begins to decline. In addition, any emissions from the disposal or regeneration of the carbon should

be controlled. Control efficiencies of 97 to 99 percent have been demonstrated for carbon adsorbers in many applications.

**Biofiltration.** While covering odorous materials with soil is a longstanding odor control practice, the commercial use of biofiltration is a relatively recent development. Biofilters reproduce and improve upon the soil cover concept used in landfills. In a biofilter, gas emissions containing biodegradable VOCs pass through a bed packed with damp, porous organic particles. The biologically active filter bed then adsorbs the VOCs. Microorganisms attached to the wetted filter material aerobically degrade the adsorbed chemical compounds. Biofiltration can be a highly effective and low-cost alternative to other, more conventional, air pollution control technologies such as thermal oxidation, catalytic incineration, condensation, carbon adsorption, and absorption. Successful commercial biofilter applications include treatment of gas emissions from composting operations, rendering plants, food and tobacco processing, chemical manufacturing, foundries, and other industrial facilities.<sup>18</sup>

##### b. *Condensation*

Condensers work by cooling the vented vapors to their dew point and removing the organics as liquids. The efficiency of a condenser is determined by the vapor phase concentration of the specific organics and the condenser temperature. Two common types of condensers are contact condensers and surface condensers.

##### c. *Absorption*

In absorption, the organics in the vent gas dissolve in a liquid. The contact between the absorbing liquid and the vent gas is accomplished in spray towers, scrubbers, or packed or plate columns. Some common solvents that might be useful for volatile organics

<sup>18</sup> Mycock, J.C., J.D. McKenna, and L. Theodore. 1995. Handbook of Air Pollution Control Engineering and Technology.

include water, mineral oils, or other non-volatile petroleum oils. Absorption efficiencies of 60 to 96 percent have been reported for organics. The material removed from the absorber can present a disposal or separation problem. For example, organics must be removed from the water or nonvolatile oil without losing them as emissions during the solvent recovery or treatment process.

d. *Vapor Combustion*

Vapor combustion is another control technique for vented vapors. The destruction of organics can be accomplished in flares; thermal oxidizers, such as incinerators, boilers, or process heaters; and in catalytic oxidizers. Flares are an open combustion process in which oxygen is supplied by the air surrounding the flame. Flares are either operated at ground level or elevated. Properly operated flares can achieve destruction efficiencies of at least 98 percent. Thermal vapor incinerators can also achieve destruction efficiencies of at least 98 percent with adequately high temperature, good mixing, sufficient oxygen, and an adequate residence time. Catalytic

incinerators provide oxidation at temperatures lower than those required by thermal incinerators. Design considerations are important because the catalyst can be adversely affected by high temperatures, high concentrations of organics, fouling from particulate matter or polymers, and deactivation by halogens or certain metals.

5. *Special Considerations for Land Application Units*

Since spraying wastes increases contact between waste and air and promotes VOC emissions, if the waste contains volatile organics you might want to choose another application method, such as subsurface injection. During subsurface injection, waste is supplied to the injection unit directly from a remote holding tank and injected approximately 6 inches into the soil; hence, the waste is not exposed to the atmosphere. In addition, you should consider pretreating the waste to remove the organics before placing it in the land application unit.

## Protecting Air Activity List

We recommend that you consider the following issues when evaluating and controlling air emissions from industrial waste management units:

- ☐ Understand air pollution laws and regulations, and determine whether and how they apply to a unit.
- ☐ Evaluate waste management units to identify possible sources of volatile organic emissions.
- ☐ Work with your state agency to evaluate and implement appropriate emission control techniques, as necessary.

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